THE JOURNAL OF GAS LIGHTING
WATER SUPPLY & SANITARY IMPROVEMENT

VOL. LXXIII. No. 1867.] LONDON, FEBRUARY 21, 1899. [51ST YEAR. PRICE 6d.

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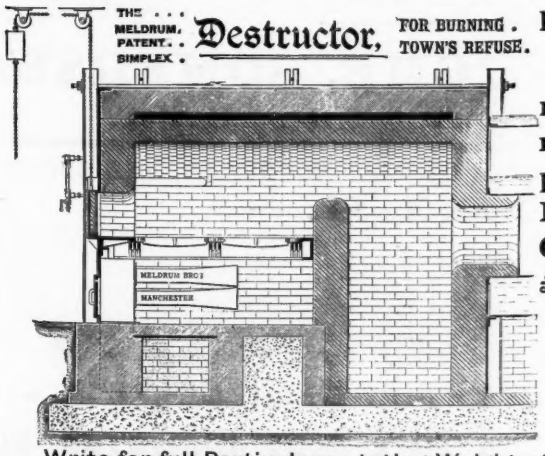

At Hereford City the Sewage Farm is now worked entirely with power from refuse, 1¼ million gallons being pumped per day, besides Sludge-Presses, Sludge-Pumps, and Lime-Mixers—the saving in Cost of Coal (not now used) being about £300 per annum.

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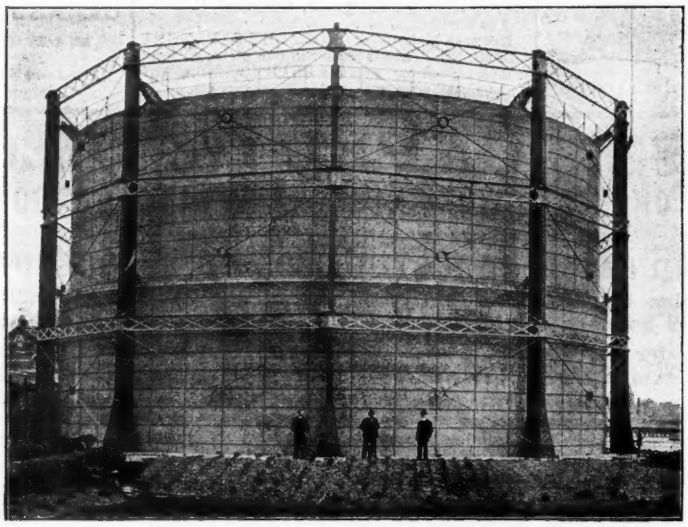

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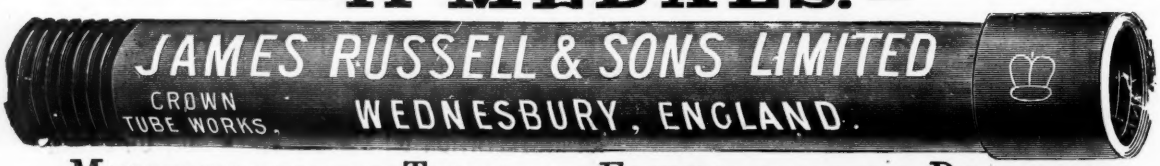

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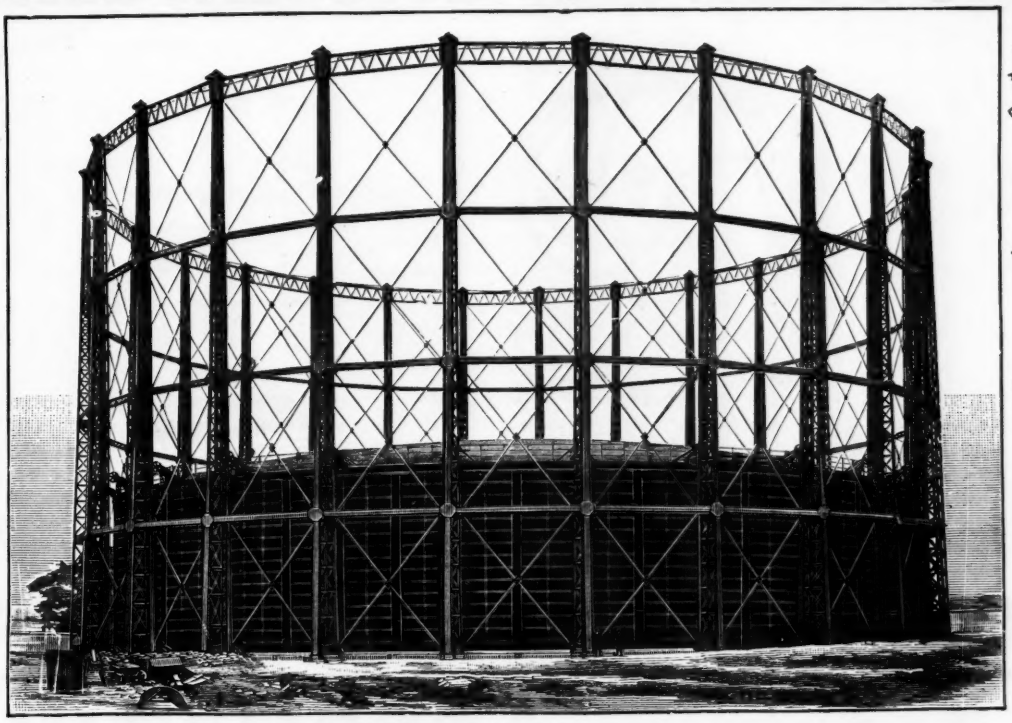

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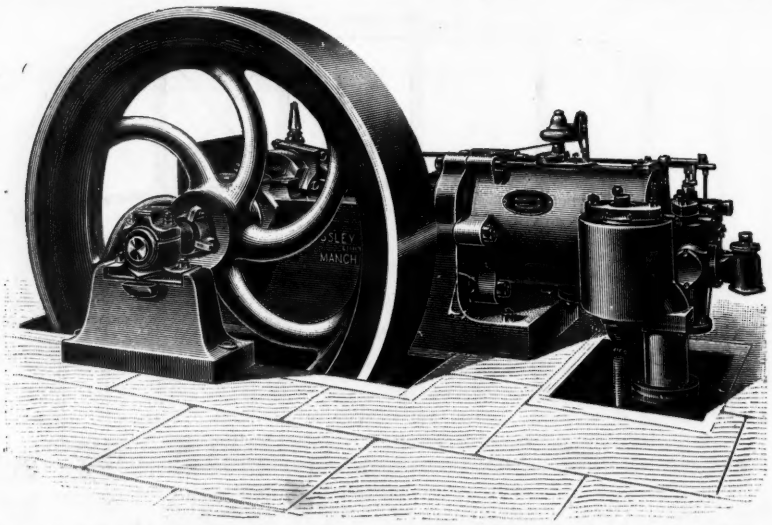

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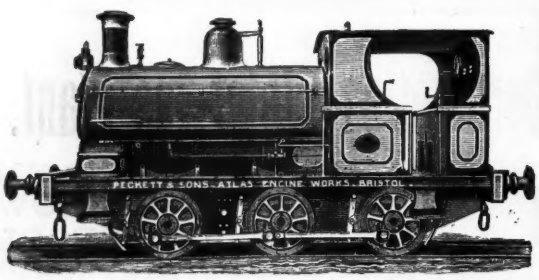

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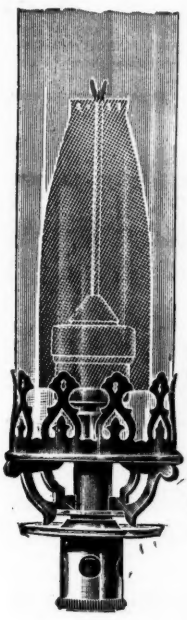

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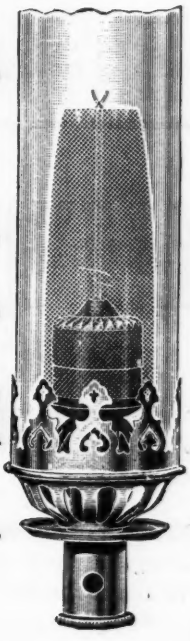

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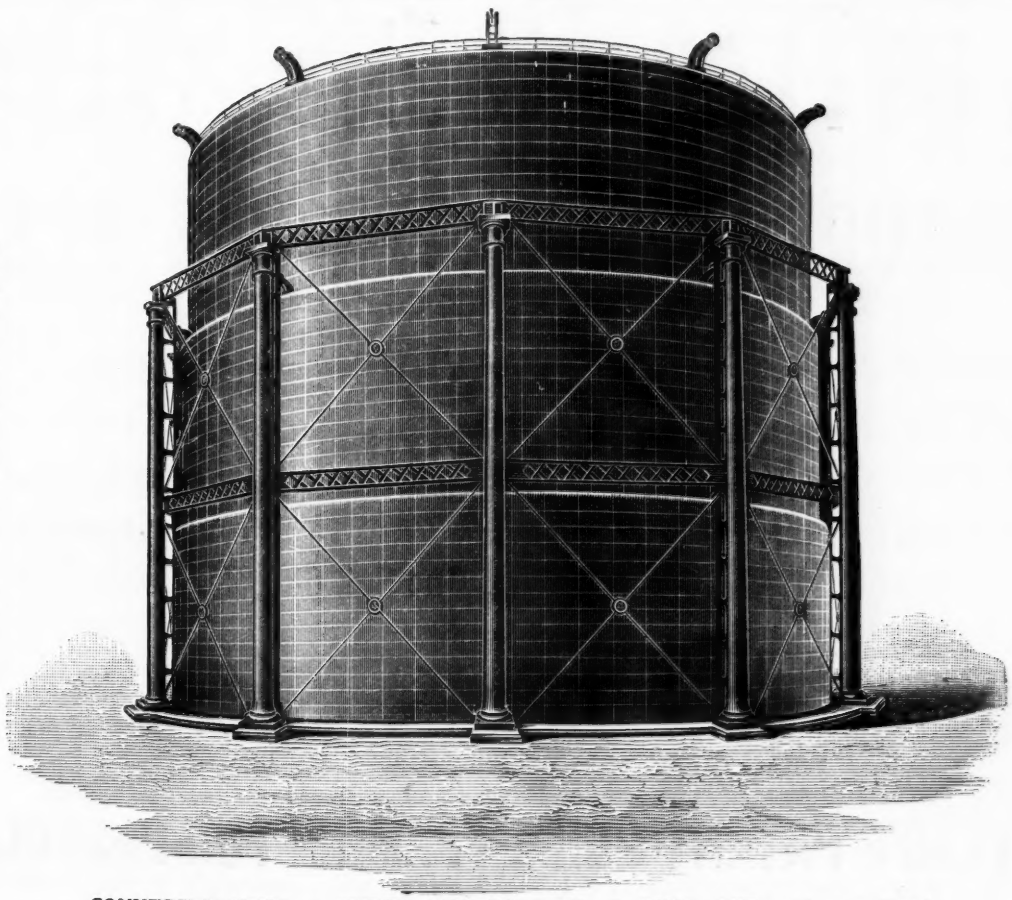

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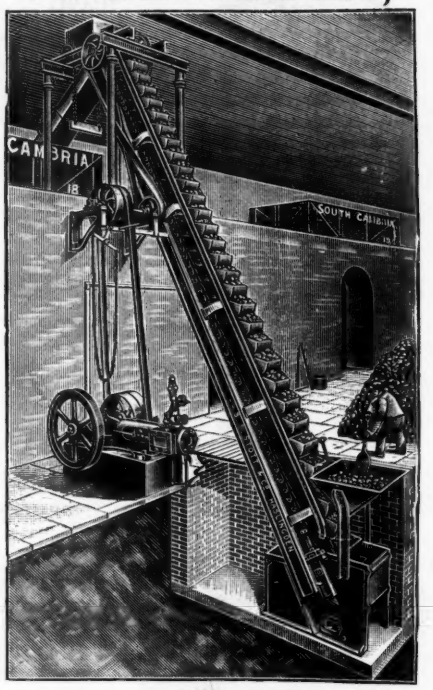

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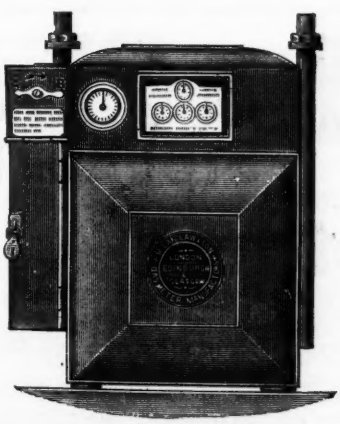

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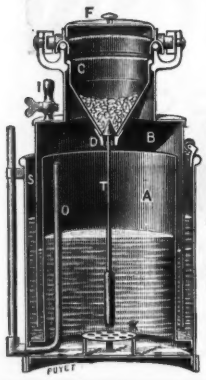

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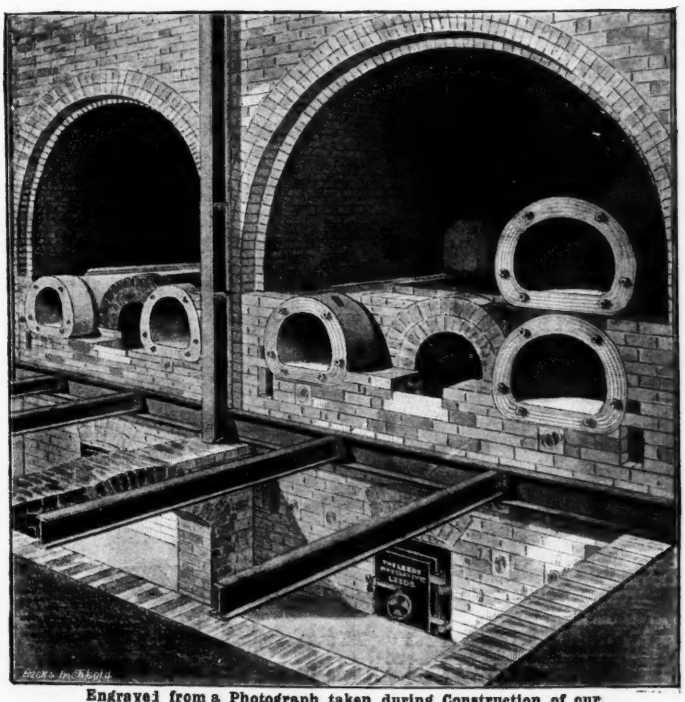

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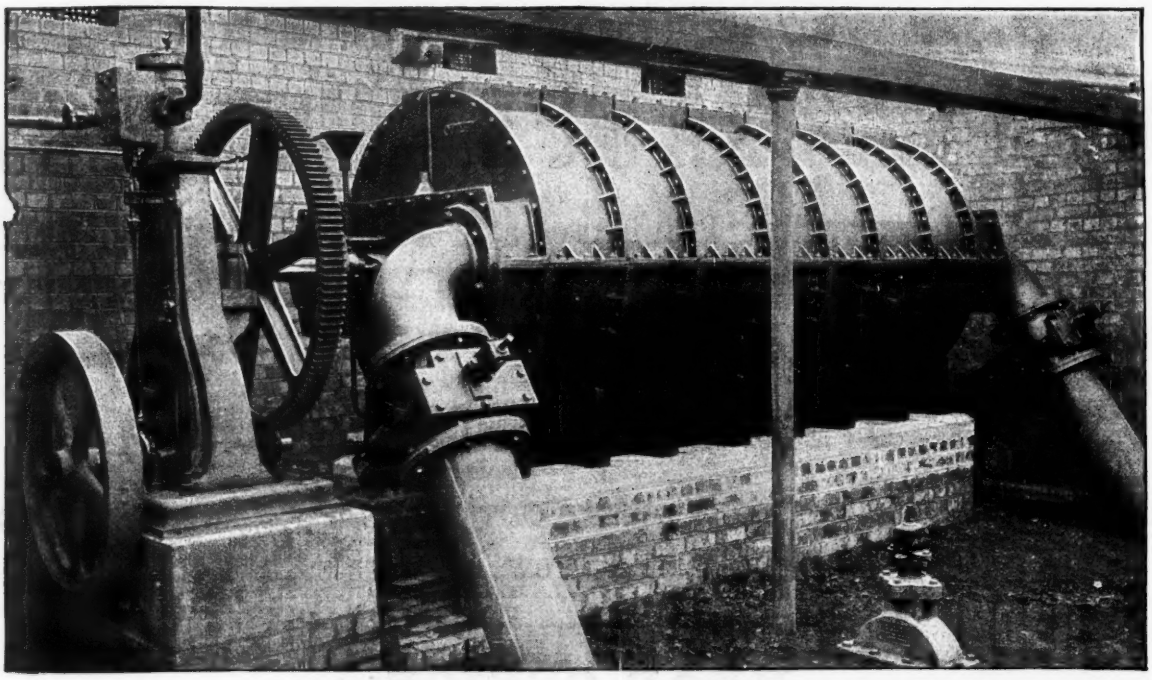

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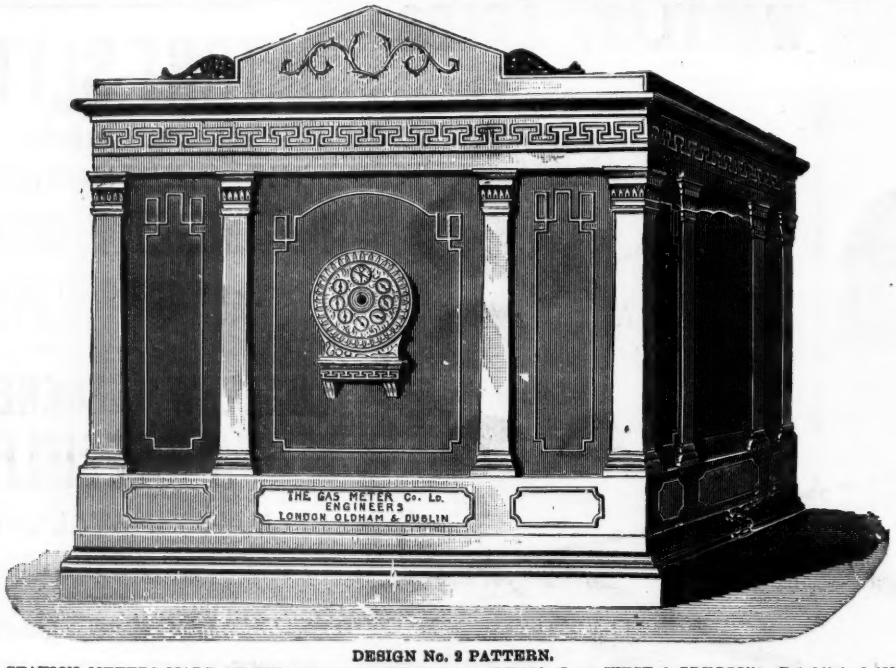

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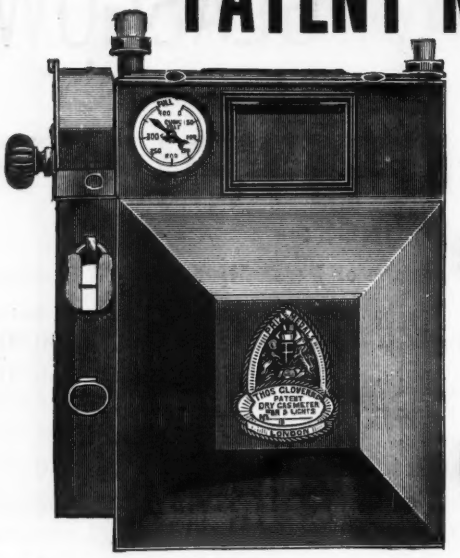

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EDITORIAL NOTES.

The Report of the Home Office Committee on Carburetted Water Gas—A Protest.

In many gas-offices last week, there must have been heard exclamations to the effect of the familiar Adelphi tag, "The blow has fallen!"—spoken with reference to the report of the Home Office Committee on carburetted water gas. For, as will be agreed by every practical gas manufacturer who has seen the recommendations of the Committee, if these are made operative by Act of Parliament, this branch of the illuminating gas industry of the United Kingdom will be stopped off everywhere but in London and the largest towns. This is the issue raised by the report; and those who are interested in the British gas industry must face it. Happily, it is often a long way between the presentation of a report by a Departmental Committee and legislation on the subject. In this case, we cannot think that the Home Secretary will be advised that an Act to carry out the generally futile and sometimes childish recommendations of the Committee could pass the ordeal of Parliament. The summary has "panic" written all over it; and we know where that comes from. It was mostly manufactured in Liverpool, and would never have been encouraged at the start if the gas supply of the city had been in the hands of the Corporation. This suggests one objectionable aspect of the Committee's findings—their proposed restrictions would never press equally, in practice, upon Gas Companies and Gas Committees of Corporations. There does not appear to have been a man upon the Committee who was able to grapple with the subject of carburetted water gas from the position perforce occupied by the practical gas maker. The doctors carried all before them; and their sapient counsels remind one of the wisdom of Coroners' juries.

The Committee were frightened because there are no legal restrictions at present to prevent any gas undertaking changing completely over from coal-gas to carburetted water-gas manufacture. This is so; and some of the witnesses called to instruct the Committee on the point did not hesitate to claim their full liberty of action in this regard. Then the Committee learnt from other sources, with horror, that where this thorough change has actually taken place—as in some American towns—the mortality from gas poisoning has markedly increased. The consequence of taking these two discoveries together is the alarmist tone of the recommendations. The bulk of the report itself is not so panic-stricken. Indeed, it very fairly refers the risk of carburetted water-gas supply to the actual conditions, and records the significant conclusion that most of the cases of accidental carburetted water-gas poisoning have occurred in places which never should have been lit by gas at all. Obviously, if one is to deal with this aspect of the matter by Act of Parliament, the sanitary authorities of towns will have plenty of additional work to do. The Committee fail to allow sufficiently, or indeed at all, for the common-sense extra-legal power of adjustment which rarely fails to operate in time in matters of this kind. They belong to the type of sanitary reformer who would appoint inspectors to see that people take a bath once a week, rather than leave the appreciation of cleanliness to grow.

Lest we should be thought too severe on the Committee and their recommendations, let us recall what has actually come to pass in respect to the fixing of gas-fires, gas bath-heaters, and even gas-kitcheners. The appliance called a "geyser" was once responsible for some most deplorable fatalities; and if the statistician had been set going at the time, he might easily have prepared some ghastly computations to show what effect the multiplication of geysers might be expected to have upon the next Census returns. It was the same with gas-fires in bedrooms. Similarly, many accidents happened before people grew accustomed to gas cooking-stoves. No statistical tables of comparative mortality were prepared on the basis of this early experience; and the higher risk attending the increased convenience of such appliances has corrected itself. It seems to be a law of civilization that a general advance of convenience, economy, or time and labour saving in any direction, should be attended with a proportion of individual risk. If there were no railways, there would be no railway accidents. Substitute electric for horse tramway traction, if you like; but be prepared to kill a few more heedless, stupid, and innocent people.

We have always recognized in these columns that the

reckless American fashion of carburetted water-gas supply would never do for this country; but the same objection applies to the unfenced American railway, as well as to the ramshackle Yankee electric tramway. Further, we have often argued that the case for carburetted water gas must be made out, for the United Kingdom, on the ground of the general advantage. It is not a question of a gain of a penny per 1000 cubic feet, or any such matter. "Ex-"pediency," in the parliamentary sense, and in this connection, implies more than a small balance of benefits over drawbacks. While we have been watching, the case for carburetted water gas has been growing and strengthening. It is impossible now to resist the proof that there must be a good deal in it for it to have succeeded so strikingly. All the same, the general justification for regulation of this and every other industry in the interest of the public safety remains. No true friend of the British gas industry, moreover, would desire to see it delivered from the thraldom of the coalowners and the labourers' Trade Unions merely to fall under the domination of the Oil Kings. Most of the danger before which the Home Office Committee quailed is hypothetical, and will never be realized. If it were, their remedies would be ineffectual. Actually, the gas industry of this country is in the favourable position of having the two manufacturing processes to play off against one another. If Government is to interfere at all, it should be in order to preserve this condition—not to upset the balance by panicky, unequal, pedantic interference with the trade at the instigation of those who do not really understand it or its needs.

More Flash-Point Politics.

THE petroleum question has been again actively discussed during the past week; and we are favoured in the present issue of the "JOURNAL" with three additions to the controversy on this subject. There was a deputation of representatives of the grocers' trade to Mr. Jesse Collings, the Parliamentary Secretary to the Home Office, on Thursday, who gave their own views upon the three branches of the inquiry conducted by the Petroleum Committee. One speaker referred most preventable lamp accidents to flimsy and dangerous lamps; another asked that there should be no limit to the amount of petroleum oil allowed to be stored under proper conditions; and a third stated that "the "vendors who provided oil for the ten million lamps in "use every night and day in Great Britain, wished to "enlist the sympathy of the Department in opposing any "legislation which suggested the raising of the flash-point "—the evidence before the Committee being entirely in "favour of no alteration." In reply, Mr. Collings stated that he was unable to formulate the conclusions of the Government on the evidence taken by the Committee. In the counsels of the Government, the safety of the public is the first consideration; and afterwards they will be anxious to avoid unnecessary interference with this great trade. Mr. Collings intimated that some regulation of the handling and storage of petroleum will probably be proposed; but he admitted that the question of raising the flash-point is "very disputatious." He requested the public not to permit themselves to be led away by sensational statements, but to confine their attention to facts and experience. The caution is not needless. Naturally, the reluctance of the Government to commit themselves to any Bill which would upset the petroleum oil trade without furthering the cause of public safety, is not shared by those "experts" the editors of the newspapers who have taken up with the high-flash cry. These omniscient gentlemen know all about it. It is distinctly funny, however, that the "Daily News," while perceiving that "there is a painful "conflict of opinion as to whether lamp accidents should "be attributed to cheap lamps or to low-flash oil," thinks that "Parliament could not do better than accept and pass "Mr. Reckitt's simple measure for raising the statutory "flash-point." Hit or miss, all is one so long as something is done. It is an artless idea of the spirit in which the great work of legislation should be undertaken. Let us pass an Act—never mind if it should afterwards turn out to be a wrong one—while the responsible Government Department is considering how best to advise Parliament in the matter! Happily the present Administration is not in the habit of doing business in this way.

The "Communicated Article" with which we are favoured by Mr. Alexander Robertson is well worth reading at this juncture. The same remark applies to Mr. D. R. Steuart's long letter. Mr. Robertson admits that the flash-points of lamp oils are no indication of their comparative safety in use. American kerosene has a flash-point somewhere above 73° Fahr.; but it is cool and clean burning. So is Scotch paraffin oil. Russian oil, however, has no paraffin, and burns at a much higher temperature, with more liability to clogging. Hence it by no means follows that because a high-flash American kerosene or Scotch paraffin oil may be safer than the lowest flashing oil of their kinds, therefore a Russian oil with an equally high or even a higher flash-point is equally safe. This admission comes very near throwing up the case of high-flash as the sole and sufficient gauge of safety. Mr. Robertson falls into only one error—he begs the whole question when he declares that 73° Fahr. is too low a flash-point. He fails to grapple with the allegation that this particular point is a function of the testing apparatus as well as of the oil, and that oil which shows a flash at 73° in the modern Abel close-test apparatus, will give the same effect only at 100° in the apparatus that Dr. Letheby had in mind and in use when he laid down the rule that mineral oil which did not flash below this point is perfectly safe to handle, store, and use—that this, in short, is a reliable dividing-line for the purpose of distinguishing between mineral oil and mineral naphtha. Why, even Mr. Steuart, in the volume of his verbiage, gives this part of the question in a nutshell. He remarks that the original American test was by means of "an open vessel," and states that this test "we all know "now to be deceptive, and to give a point 27° higher than "the truth." Furthermore, this open test is now translated into the close test, which makes the legal flash-point just 100° − 27° = 73°, as is aforesaid. Where, then, is the betrayal of public interest? We have asked whether it is not the same old kerosene that once flashed in an open cup at 100°, and now does the same in a close cup at 73°; and Mr. Steuart says that it is. Again we ask, Where is the injury? Mr. Steuart thinks the standard flash-point should have been raised to 127° Fahr.; but that was evidently not the view of the "three Chemists."

There is a good deal of logic-chopping over this question of testing for the flash-point, which is, after all, of no great practical consequence. At any rate, the paternal German Government does not think so, nor does the Government of India. Surely, a lamp oil which is passably safe to burn in Calcutta is safe enough for England. We are pleased to have obtained from our esteemed correspondents confirmation of our previous opinions—(1) that the flash-point of mineral oil is not everything in regard to its safety in burning; (2) that the original open test of 100° Fahr. was identical with the modern close test of 73°; and (3) that the cheap American "Tea Rose" lamp oil is essentially the same as the old "kerosene." The next thing we should like to know is the probable effect of depriving the British market of all this particular product.

The Scandal of the New York Gasholder Accident.

THE story of the New York gasholder tank accident must, we suppose, be regarded as completed by the verdict of the Coroner's Jury given in our news columns on the 7th inst. (*ante*, p. 312). Having now had the benefit of the views of our American contemporaries on the whole incident, and its legal termination, we are in as good a position as we can ever expect to be for summing up the entire matter. Nothing more unsatisfactory can well be imagined in its way than the conduct and the result of the inquest. The verdict was "accidental death," as regards the victims of the catastrophe; and the Jury went on to declare that they did not know why the tank broke; that there was nothing wrong with the design or construction of the tank; and that all such work should in future be subject to proper municipal supervision and control. All there is to be said upon such findings, in such a case, with the exception of the ascription of the men's deaths to accident, in the legal sense, is that they are a monument of ineptitude. The business looks still more disgraceful to all concerned by reason of the fact of the Jury being composed of men of some pretensions to rank as experts in engineering construction. Four of them are given the idle initials "C.E." after their names; and the others are described as builders and contractors—one is actually styled a superintendent of iron-works. We are not surprised at this miscarriage. Immediately after the accident, our American contemporaries promised that there would be a thorough and searching inquiry into the cause of the breaking of the tank. But we were doubtful about it; and in first mentioning the affair on the 3rd ult., we were careful to observe

that *if* the Coroner's inquest were properly conducted, the truth about the collapse might come out. Our mistrust has unhappily been fully justified by the record; and once more an American inquest has carefully missed the chief points that needed bringing out. As to the particularly foolish recommendation of this Jury—that gasholder work should be placed under municipal control—it is worse than merely ludicrous, as coming from such a source. If all these so-called engineers and builders could not ascertain the probable cause of a breakdown that lay under their very eyes, where should America find municipal officers competent to criticize the plans and specifications of proposed gasholders? To do them justice, our technical contemporaries in the States are heartily ashamed of this empty performance. "Progressive Age" rightly and righteously goes to the root of the matter, and points out the conclusion that a Jury of shoeblacks, if they were honest, would have had no difficulty in accepting. The guide-columns were stuck on to the side plates of the tank, as shown in our issue of the 31st ult. (p. 242), in a most improper manner; and the plates themselves were as brittle as glass. The design courted disaster; and the inferior material used ensured it. If this is gas engineering, as passed in the United States, then American designers and constructors will not have much employment in countries where Coroners' inquests, or their equivalents, are not farcical performances like this New York example. All we are solicitous for is to make it quite clear to the meanest capacity willing to take in the truth, that, as was hinted when the news of the catastrophe came to hand, there is no more mystery about the cause than that such blundering, and worse, should ever have been possible in the circumstances of the case.

The Leighton Bequest—for Lamp-Posts!

It is with considerable gratification that we learn how the Leighton bequest to the Royal Academy is to be applied, with the object of carrying out the wishes of the public-spirited donor. The money is to be invested as a separate fund, bearing Lord Leighton's name; and the interest is to be expended in acquiring or commissioning works of decorative painting, sculpture, and architecture. Among the last named are specifically included street fountains, "lamp-posts," and seats. Thus at last is the British lamp-post to receive its due artistic treatment. As the "Standard" observes upon this head, "such common "objects of the London streets as lamp-posts. . . . . "stand in sore need of an artistic renaissance; and "dwellers in, and visitors to, the Metropolis will have "cause for lively gratitude to the memory of Lord "Leighton, should any real improvements in these matters "be wrought by the help of his bequest." Unfortunately, English Local Authorities are blind to their opportunities and responsibilities in such matters as these. As in the now notorious example of the new Vauxhall Bridge, the Engineer of the London County Council professes himself pleased with the design; and there is to be the end of it. Yet it ought to be pretty clear that the best way to get a suitable lamp-post for a London bridge is not to copy something to be seen in Paris. We do not want French models; but we do need something—just a taste—of the innate sense of Art of the French people, which renders them incapable of entrusting the proper work of an artist to an engineer. It does not really follow that any artist or architect can design a good lamp-post. His production may require correction for structural or other practical reasons by an engineer. But to say this is a different thing from saying that the whole task of design can be safely left to the engineer or the town surveyor.

A Bill to Penalize Trade Bribery.

The Lord Chief Justice has undertaken to promote legislation with the object of penalizing the practice of giving and receiving illicit commissions in trade. The Bill is understood to be for the extension to all commercial transactions of Lord Randolph Churchill's Act, which only applies to cases of bribery of public officers. Speaking at Kingston-on-Thames recently, Lord Russell stated that he had been forced to take this action by his knowledge, partly professional and partly judicial, of the canker of this system of secret commissions, to which, he stated, "many men who held their heads high up were parties." Of course, were Lord Russell's Act to become law to-morrow, it would not follow that the evil against which it is directed would die forthwith. All that is hoped for in this regard by those who approve of the principle of the Act is that some of those who actually follow the practice as being "the usual thing," will amend their ways when they know that there is a possibility of these leading into the felon's dock. The London Chamber of Commerce have had a Committee inquiring into this trade canker since November, 1896; and it is now announced that the report of the Committee will shortly be made public. It is known that the Committee have held many meetings, and collected a large amount of evidence; but how much is to the point, or will ever see the light, is questionable. Those who know most about the hard facts of trade and commercial life believe that this sort of earthquake cannot be cured by any kind of pill—whether legislative or otherwise. If it sounds too quixotic to say that men of the world hope most from the gradual elevation of tone and the increase of self-respect among business people, it may be suggested—not as an alternative, but only as a half-way measure—that much might be done by agreement among the leading manufacturers and dealers. The gas industry has proof of what can be brought about in this way; but the movement has not gone far enough. All the evil complained of may not be curable by a simple agreement among the leading houses not to pay bribes; but a good deal of it would be stopped at once if those who profess to suffer most would have the moral courage to refuse to continue to play their part in it. In all the industries there are certain leading "lines" of supply; and these are generally controlled by a small number of well-known firms. Common action on the part of these firms should not be out of the question, when the object is that of purifying a whole trade. If a Penal Act would help to stiffen the moral backbone of these representative manufacturers and merchants, by all means let Parliament see to it without delay.

WATER AND SANITARY AFFAIRS.

The evidence given before the Royal Commission on the Metropolitan Water Supply last week, by Mr. Edmund Boulnois, M.P., dealt in a striking manner with some vital and far-reaching questions connected with the inquiry. Mr. Boulnois holding a twofold position as Chairman of the West Middlesex Water Company and Chairman of the Staines Reservoirs Joint Committee, his remarks on the subject in hand may be said to be *ex cathedrâ*. Despite all that threatens a different issue, we may understand him as speaking with prescience when he says he is looking forward to the time when the whole of the Companies will come into one scheme of either amalgamation or federation. He discerns certain difficulties in the way of amalgamation, but does not believe them insurmountable; being encouraged in this respect by the example of the Gas Companies. Mr. Boulnois does not speak of difficulties in the way of federation. But if the Companies are not to be bought up, what is the future of the sinking fund now accumulating in the hands of the City Chamberlain? Mr. Boulnois considers that if the Companies are not dispossessed, the sinking fund will be abolished. Of course, that is a matter which Parliament can settle, if needful; power being expressly reserved to it for the purpose. But Mr. Boulnois shows that if the sinking fund goes on, it is likely to operate to the prejudice of the consumer in the case of a Company like the West Middlesex, which has reached its maximum dividend and is giving a rebate. His Company will have to pay the Chamberlain something like £20,000 per annum, which is not much less than the amount now remitted to the consumer. Even the dividend may ultimately be interfered with. Supposing purchase to be effected, and the London County Council to be the buyers, what is then to follow? Mr. Boulnois points out that if the Council proceeded to carry out their Welsh project, the necessity for so doing would be largely due to the needs of outside districts, while the expense would fall as much on the central ratepayer as on the one outside; London being made to pay for that which it did not require. The Progressives may lay hold of this, as showing an element of justice in their proposal that the outside districts should be severed from the central, and be left to their own devices. But the argument is a two-edged sword. If the outside districts create the necessity for going to Wales, then if these districts are cut off the Welsh project is not wanted. Supposing the Companies are allowed to remain *in statu quo*, as Mr. Boulnois thinks they

should be, will they have to go to Wales in order to provide for the whole of their parliamentary area? That, we submit, is a question for the shareholders, and does not affect the ratepayers. If it be said: What have the ratepayers to do with the matter, supposing the County Council to possess the water supply? the answer is that the Council have the ratepayers at their back to meet any loss that may accrue from an excessive expenditure on the enterprise. The Companies have no power to draw upon the county rate, and must pay their way from their own resources. Whatever happens, they cannot touch the ratepayer; and the charge on the consumer is restricted by Act of Parliament.

The financial advantages enjoyed by the consumers under the present *régime* appears by the evidence of several of the witnesses who speak on that side. The total amount of the rebate which has been allowed by the West Middlesex Company is shown by the Company's Secretary, Mr. Wybroo, to be rather more than £200,000. What the Companies do in time of frost was well exemplified by this witness, who stated that when the great frost of 1895 so augmented the expenditure of his Company that the income was insufficient, without reducing the rebate, to maintain the 10 per cent. dividend, the Directors decided not to interfere with the rebate, and preferred to take £20,000 from the reserve fund. The rebate itself was equal to a further dividend of 2¼ per cent. In other respects, and contrary to evidence from the County Council, Mr. Wybroo showed how the Company had exercised their financial powers in a fair and liberal spirit; foregoing advantages which they otherwise might have secured. Mr. F. Tendron, the Chairman of the Grand Junction Company, expressed the same opinion as Mr. Boulnois and Mr. Wybroo—that purchase would be no advantage to the consumer. If the Grand Junction undertaking is left in the hands of the Company, there is the prospect of a rebate at least as soon as if the property was purchased by a public authority. As for the sufficiency of the supply, Mr. Tendron declares his Company are prepared to carry out all necessary works for the requirements of the district either single handed or in conjunction with other Companies. That there is water enough, not only for the present but a long way off into the future, appears by the engineering evidence that the Companies bring forward. Mr. J. W. Restler, the Engineer to the Southwark and Vauxhall Company, gave his reckoning for 1941, for which the estimated expenditure is £2,000,000. Mr. M. W. Hervey, the Engineer to the West Middlesex Company, showed how an expenditure of £1,250,000 will meet all the demands arising in his district up to the year 1922. The question of the outer areas receives a striking illustration by the circumstance that the rate of increase of supplies in the West Middlesex district is about five outside to one inside the county of London. As to a severance of the supply between the county of London and the county of Middlesex, Mr. Hervey considers that in the case of his Company it would be accompanied by difficulties and complications such as would be almost insuperable. We apprehend that a similar objection applies generally, unless the Kent Company may be an exception. Even if anything of the kind is possible, such cutting up of the watershed cannot conduce to an economical development of the sources that exist.

The County Council, having during the last three months expended nearly £200 in analyzing the water supply, are so enamoured of the pursuit that they are resolved to examine the water still more closely, and have decided to spend nearly double the foregoing amount during the next three months for the purpose. There was a considerable quantity of analyzing prior to November last; and the entire expenditure involves a formidable sum, besides occupying the time and attention of the chemical department for a very unnecessary purpose—the same work being regularly performed by Sir Edward Frankland and other chemists of high repute. When the question came on at the Council meeting last Tuesday, the vote that was asked for was met with protests from Mr. Campbell and Colonel Ford, on the very sensible ground that the proposal meant a sheer waste of public money. But the protests were in vain, and the money will be spent; while the *agenda* for to-day shows that even this is not all. The purity of the supply is established beyond all contradiction from the County Council, if, indeed, any contradiction happens to be forthcoming. With respect to the raw river water, which may be described as the source, it is satisfactory to find the Conservators of the Thames diligently engaged in carrying out the Act of 1894, by which they obtained increased power for preventing the pollution of the stream. A deputation from various District Councils in the watershed has asked the Conservators to relax their energies in this respect, so as to allow the tributary streams in rural districts to receive sewage, if there was no apparent harm done to the main river. Lord Valentia introduced the parties presenting this kind of plea; and Sir F. Dixon-Hartland, as Chairman of the Conservancy Board, gave a reply which evidently carries with it the force of public opinion. The Conservators are bound to carry out the law, and its operation in the course of the last four years has improved the purity of the Thames by one-third. The parishes are at liberty to purify their sewage according to the plan they consider best; and the Chairman of the Conservators is able to state that under this recent Act pollutions have been diverted from 362 places above the water intakes, and this from a district with nearly half-a-million of inhabitants. It is for results of this nature that the London Water Companies pay to the Conservators several thousand pounds per annum. As to the purity of the water supply, a remarkable and instructive case has just occurred at Notting Hill, where a sample of Grand Junction water has been condemned by the Vestry Analyst, while a precisely corresponding sample has been highly approved by Sir W. Crookes and Professor Dewar, who indignantly denounce "the reckless circulation of grossly-"exaggerated statements as to the bad quality of the water "supplied by the London Companies."

The Corporation of the City have set a good example to the Authorities at Spring Gardens. The whole Court of Common Council met in Committee on Tuesday to consider what action the Corporation should take with respect to the future supply of water to the Metropolis. After discussing the matter in private for two hours, it was resolved that the Corporation should take no action whatever till the Royal Commission had reported. When this event is likely to happen was the subject of an inquiry addressed to the Government in the House of Commons on Thursday by Mr. Stuart. In reply, Mr. Balfour said he was informed that the Commissioners are at present unable to fix any date for the presentation of their second report. There was simply a promise that there would be as little delay as possible after the conclusion of the evidence. Of course, the Progressives, as we can see by their weekly organ, are impatient at the circumstance that the Commission are now engaged in taking evidence from witnesses on behalf of the Water Companies. Undoubtedly it is a long inquiry; and the County Council have done their part in making it so. But for them, there might have been no inquiry at all; and it is just possible they will gain nothing by it.

The Government Water Bill.—In the House of Commons yesterday, Mr. Chaplin introduced and explained the scope of this Bill, which is to enable the London Water Companies to supply each other in cases of emergency.

The Report of the Departmental Committee on Water Gas.—At the request of several subscribers, we have secured a number of copies of the above-named report, which we shall be pleased to forward to any correspondent requiring a print, on receipt of 1s. 6d., to cover cost and postage.

Institution of Mining Engineers.—The annual general meeting of this Institution will be held in the North Staffordshire district to-morrow and Thursday. The first day will be devoted to papers and discussions; while the second day's arrangements include an inspection of the Hatton works of the Staffordshire Potteries Water Company.

The Sulphate of Ammonia Committee's Prize Essays.—An unexpected delay has arisen in the adjudication of the five hundred guinea prize offered by the Sulphate of Ammonia Committee for the essays which were advertised to be sent in as far back as Nov. 15 of last year. It may be remembered that the judges appointed to examine the essays were Mr. William C. Little, a member of the late Royal Commission on Agriculture, and Dr. J. A. Voelcker, the Consulting Chemist to the Royal Agricultural Society of England. The former gentleman died before the essays were received, and in his place Mr. Samuel Rowlandson, a member of the Council of the Royal Agricultural Society, was appointed. Mr. Rowlandson has, however, unfortunately since been seized with a bad paralytic stroke, which has altogether incapacitated him from undertaking the work. Mr. Clare Sewell Read has now been approached, with the object of getting him to accept the position of judge in the matter of the essays, in conjunction with Dr. Voelcker, who is already so far advanced in his examination of the essays as to be prepared to make his report whenever it may be required.

ESSAYS, COMMENTARIES, AND REVIEWS.

GAS AND WATER COMPANIES IN THE STOCK MARKET.

(For Stock and Share List, see p. 470.)

SINCE the settlement of the recent heavy account, a complete change has come over the aspect of affairs in the Stock Exchange. Everything has rested to take breath after the pace at which it had been forced along; and so the markets all round have had a quiet time. But the inactivity did not seem to produce weakness, except where special circumstances affected special lines, and some departments have made a good advance. The Money Market was disposed to be firmer; but there is no change of any pronounced character. Business in the Gas Market was tolerably brisk on the whole, although the days of greatest activity were separated by periods of quiet. With the exception of the leading issue, which had a relapse after its recent rise, all changes of quotation were for the better. But they were not numerous; and they were only moderate in degree. Gaslight ordinary opened at 119; and after a little hesitation began to give way. Considerable dealings only carried it lower; and it closed weak with a final mark of 115½. The secured issues, however, were in good favour; and the preference advanced a point. South Metropolitan was rather quiet; and at first it did not appear to be over strong. But it rallied later; and the quotation gained a point. Commercials were again without a single transaction. The Suburban and Provincial group were almost wholly devoid of business; and the only change was an advance in Crystal Palace preference, in view of the great improvement in the Company's business during the past half year. Bromley are going to make a slight increase in their rate of dividend—viz., 12 per cent., less income-tax, instead of 11½ per cent. net. Tottenham and Edmonton quotation is temporarily withdrawn from the list. The next quotation will be of the reconstructed capital, in accordance with the Company's recent Act of Parliament. The Continental group were rather quiet. Steadiness was the general characteristic, while European advanced. Of the rest, the debentures of Buenos Ayres and River Plate advanced. Business in the Water Companies was of the quietest description; and practically quotations may be set down as unchanged.

The daily operations were: Transactions in Gas were only moderate on the opening day; and no variations in price were made. Things were a little more animated on Tuesday, but not much; and again the old quotations were left standing. Business in Gas was no more than moderate on Wednesday. Gaslight ordinary began to decline, with a fall of ½; but Crystal Palace preference advanced 2. Gaslight ordinary provided the bulk of the business on Thursday, and fell 1; but the preference was 1 higher. South Metropolitan and the debentures of both Buenos Ayres and River Plate rose 1 each; and European ½. In Water, West Middlesex 4½ per cent. debenture receded 1. There was a lull in activity on Friday; and quotations did not change. Saturday was as active as any day of the week, especially in Gaslight ordinary, which fell 1 more.

ELECTRIC LIGHTING MEMORANDA.

The High-Handed Electric Lighting Company and the Obstinate Vestry—The Nernst Light and the Older Systems—Inquiries and Criticisms—Electricians on the Defects of the Incandescent Carbon Lamp.

BY way of rounding off the incident narrated in this column a fortnight ago, of the high-handed Electric Light Company of Wandsworth and the obstructive Vestry of Battersea, it must be recorded that the same transaction formed the subject of Police Court proceedings in the South-Western Court, before Mr. Lane, Q.C. The Vestry prosecuted the Company for breaking up and opening the pavement of Trinity Road, Wandsworth Common, without having given notice of such intention as required by law. The Solicitor to the Vestry was fain to acknowledge that the proceedings in the High Court to compel the Company to remove their main had failed. He was careful to inform the Magistrate, however, that the Judges had characterized the action of the Company as high-handed and utterly illegal; to which it was retorted by the other side that the High Court described the treatment of the Company by the Vestry as unreasonable. After hearing all this, the Magistrate very properly fined the Company £2, with £2 2s. costs, for their undeniable breach of the law relating to the breaking open of metropolitan highways. The whole affair is to be taken as a warning to local authorities acting as urban sanitary authorities that they must administer the law of highways strictly in accordance with their public duty as waywardens. This may not be the legal definition of the position; but the gist of the matter is simple and intelligible enough. A local authority must not use their statutory powers over the highways in their interest as traders in electricity or what not, to the obstruction or injury of a trade competitor. In these days of swelling municipal ideas the reminder is not superfluous.

The electrical interests centred in the older forms of electric light, carbon arc and incandescent, are not altogether prepared to shut up shop because of Mr. James Swinburne's thunderbolt "from the blue" with the label "Nernst." After the reading of the paper at the Society of Arts, there arose a chorus of praise of the new invention; for such Professor Ayrton allowed the Nernst lamp to be, in the proper sense of the term. He said it had long been known that an insulator could be made to pass electricity by heating it; and also, on the other hand, that carbon filament lamps have certain drawbacks. Many attempts have been made to use refractory earths in the construction of incandescent electric lamps; but nobody before Nernst seems to have thought of the simple expedient of heating a very good insulator, which is at the same time a refractory substance, with a match or spirit lamp, applying a current of suitable potential, and thus obtaining a brilliant light. Mr. W. M. Mordey remarked that in all probability there would now be plenty of people writing to the newspapers to say that they did the same thing in their back kitchen 20 years ago. The voice of criticism was scarcely heard above a whisper after Mr. Swinburne's brilliant performance; but still it was not altogether unattended. People inquired about the deterioration of the luminous rods, asked how the lamps gave out when they did go; and it was hinted that these electrical novelties did not always answer the first expectations formed of their experimental embodiments. Mr. Siemens instanced the storage battery as one of those things which have not borne out the promise of their youth.

Later inquiries touch upon what may be expected to prove the peculiar weaknesses of electrolytic conductors at high temperatures. How will the joint of the rod with its holder stand? Is it true that the lamp will only work with the alternating current, because of the excessive electrolytic action of the continuous current? It is a matter of course that a big company flotation will soon be attempted in this connection; and our contemporary, the "Electrical Review," very appropriately publishes some information about the German Company that own the Nernst lamp at home. It appears that the Company in question do not expect a revolution in electric lighting to follow from the introduction of the new lamp in the German market. It is credited with greater economy of current and higher illuminating power than the carbon filament lamp; but these advantages are set off by two drawbacks. In the larger sizes, the Nernst lamp requires a heating coil to render the rod conducting, which has afterwards to be cut out; and the lamps give off much more heat than the carbon bulbs. It does not strike us that these drawbacks are serious. It will be possible to "get a light" from the Nernst lamp, whereby it may also set fire to things. There is both good and bad in this quality. With regard to the asserted complication of the larger sizes of these lamps, it must be remembered that the comparison here is with the electric arc lamp, which possesses not less complication and needs more attention. English investors may nevertheless be warned against the notion that the Nernst lamp will bear any amount of over-capitalization. It will go slowly, if it goes at all.

It is very curious to note how ready the vendors and users of electricity for lighting who heard Mr. Swinburne were to find fault with their old servant, the incandescent carbon lamp. Mr. R. S. Erskine confessed it would be an enormous boon to central station managers when they could get something better than the existing 200-volt lamp, "though he did not know that they were much worse than the 100 volts." The truth is that the incandescent gas-burner has knocked out the nominal 8-candle lamp which the electricians palmed off upon the guileless public as equivalent to the old flat-flame gas-burner. The electricians used to assure their customers that 8-candle lamps were quite powerful enough for all ordinary domestic requirements; and talked artistically about the grateful effect of a low-toned illumination. The reason was that they feared popular indignation at the expense, if people went in generally for 16-candle or 20-candle power lamps. Yet the public will not rest content with a nominal 8-candle power lighting unit. They want something brighter; and this means more current. Moreover, it is confessed that "the great trouble with all central stations is that the lamps take more current than they used to." Mr. Mordey confirms the statement that the lamps in general use give a great deal of dissatisfaction. Evidently, the Nernst lamp comes in the nick of time to restore the confidence of electricians in their ability to hold their own against the incandescent gas-burner. It remains to be seen whether this confidence is well founded. As Mr. Swinburne remarked, "it is best not to be sanguine." The probability is that Nernst lighting will take a considerable time to develop, if only because it offers greater flexibility than either the arc or the vacuum bulb system.

The Effects of Frost on Portland Cement.—According to a paper by Mr. C. H. Godfrey, given in the "Proceedings of the Institution of Civil Engineers," describing some experiments carried out at the cold-air stores of the Manchester Corporation, though cement may at first appear to be damaged by frost, it is found to improve in course of time, though it probably never wholly regains its original strength. Frost only partially suspends chemical action in the setting of cement. The greatest damage may be expected when the cement is frozen soon after mixing; but the ill-effects are minimized by the amount of setting attained prior to the action of the frost. The liability to damage decreases with the amount of water remaining in the cement. The use of warm water, by its tendency to promote rapidity of setting, enables a cement better to evade frost.

THE REPORT OF THE HOME OFFICE COMMITTEE ON CARBURETTED WATER GAS—A MEDICAL SCARE.

ELSEWHERE we publish the text of the unanimous report of the Departmental Committee appointed just a year ago by the Home Secretary "to inquire into the manufacture and use of water gas and other gases containing a large proportion of carbonic oxide." With it we give the important statement of Dr. J. S. Haldane, F.R.S., upon which the finding is chiefly based. In due time we shall publish an abstract of the remainder of this important Blue-Book, for the sake of the record. All gas engineers and managers will, of course, arm themselves with the original. The issue of this report, with its definite proposal of legislation to give effect to its recommendations, creates a crisis in the contemporaneous development of the gas industry of the country; as it is only necessary to glance over these recommendations to receive the firm impression that if there is to be legislation upon these lines, carburetted water gas will cease to be an available resource for British gas undertakings, with the possible exception of a very few establishments peculiarly circumstanced and of the largest size. It would be practically impossible to carry on the manufacture generally under many of the proposed conditions. This is undoubtedly a very serious matter; but there is a grain or two of satisfaction in the observation that some of the recommendations are merely absurd, while the trail of the pedant of sanitation is over them all. The idea that a Government which let loose upon the community the "conscientious objector" to vaccination could legislate in accordance with this panic report, is scarcely credible.

Having relieved our mind to this extent concerning the character of the recommendations of the Committee, we will hark back and direct our readers' attention to the report itself, and the manner of its production. The Departmental Committee consisted of: Lord Belper; Mr. H. H. S. Cunynghame, an Assistant Under Secretary at the Home Office; Dr. Haldane; Dr. Parsons, an Assistant Medical Officer of the Local Government Board; and Professor William Ramsay, F.R.S. The Secretary of the Committee was Mr. John Pedder, of the Home Office. The first thing to strike one about the composition of this Committee is the strong medical and professorial element; and the absence of any representative—besides the noble Chairman—of that business spirit and independent judgment which have been needed before now to keep even doctors within the bounds of reason. From such a body, on general principles, one would quite expect some report like those editorial comments of the "Lancet," of the "death in the pot" order, which occasionally go the round of the press, and only cause the irreverent to smile and marvel that we are yet able to live. What would be the result, one wonders, of taking the official judgment of a medical commission on the practice of treating paupers to Christmas fare? Judging by statistics, this is a particularly deadly proceeding. We do not accuse gentlemen like Drs. Haldane and Parsons and Professor Ramsay of exhibiting unduly the narrowness of the specialist; but all the same, they might have been balanced by specialists of another order—or, better still, have acted as witnesses before a tribunal practised in dealing with evidence on matters of fact, and expressions of professional opinion.

When the terms of the reference are studied, it becomes apparent that they direct an inquiry into both matters of fact and questions of opinion. The first direction to the Committee is to ascertain "the extent to which water gas and other gases containing a large proportion of carbonic oxide are manufactured and used for heating, lighting, and other purposes." This is a simple matter of statistics. Next, the Committee are to find out about "the danger attending such manufacture and use"—here, statistics must be supplemented by expressions of opinion. The last direction is very sweeping. It asks for a statement of "the means by which such dangers may be removed or diminished, either by the discontinuance of the use of such gas or gases or otherwise; and what regulations for the prevention of danger should be established." The drafting of this clause is thoroughly bad. It reads as if the existence of "dangers" was to be understood; while as to the "means" of procuring the discontinuance of the use of gas or anything else decided to be contrary to the interest of public security, the Home Secretary surely did not need a Committee to tell him that he could proceed by Bill. However, the report purports to be an answer to these directions; and up to a point, and in some respects, it is a very good and satisfactory one.

The report plunges straightway—rather too precipitately, indeed—into the matter of carburetted water-gas manufacture. It was to have been desired that the Committee should make it quite clear that their inquiry was ordered directly in consequence of the adoption of carburetted water-gas manufacture by British gas undertakings. Before this occurred, no such investigation was thought necessary. The manufacture of carburetted water gas having become established in the United Kingdom—originally for the purpose of enriching the bulk of the coal gas, as the report states, and afterwards as a method of production in bulk—the question to be first answered by the Committee resolves itself into the simple query, What difference does this modification of the manufacture of illuminating gas make to the general public?

The report is not absolutely clear in the framing of this fundamental question, though the whole of it is in answer to it in different aspects. It is admitted fairly enough that some British gas managers make carburetted water gas in considerable quantities because it has advantages which the Committee cannot presume to pronounce upon. They do concede, however—and the concession is of great significance, both on the merits and with reference to their own recommendations—that the "emergency value" of carburetted water-gas plant is of considerable importance to the public. They talk of only one kind of "emergency"—that due to fogs; but they fail to recognize what may be called the "police value" of the same plant. Many a time the knowledge that the so-called auxiliary carburetted water-gas plant, standing by under lock and key, could be set to work in a few hours, has served even better than the Conspiracy and Protection of Property Act in subduing the forces of disaffection in gas-works. Strike agitators have told those whom they wished to make their dupes that the Magistrates would never care to put the law in force against a thousand or so strikers; but these fomenters of industrial strife have never cherished any illusions as to the potentialities of the carburetted water-gas producer.

The danger to life in connection with the manufacture of carburetted water gas is found to be negligible. And in the ordinary way of distribution and use, there is no difference to the public between this gas and coal gas. "Danger arises only when the gas escapes unconsumed;" but even this is a question of circumstance, and of degree. The Committee agree that "in the day time" the amount of carbonic oxide in town's gas is "not of serious consequence." Moreover, small leaks of gas, as from defective fittings, are declared not to be formidable. The great conclusion is "that the prospect of any serious result from the distribution of gas containing a high proportion of carbonic oxide is practically confined to cases of large escapes into rooms where persons are asleep." This is perfectly just. When it comes to the valuation of this risk, the obstacle presents itself of lack of data, both positive and comparative. There is no reliable evidence of British origin competent to assist the judgment in this regard. Recourse must be had to the United States; and here the "red light" is shown by those reports of the Board of Gas and Electric Light Commissioners of the State of Massachusetts, the gravity of which in this regard we have always admitted. Dr. Parsons prepared a memorandum on the American figures, which have also been searchingly criticized by Mr. A. C. Humphreys. After all was said, and all allowances made, the Committee arrived at the conclusion that the state of affairs in water-gas America is "decidedly serious."

They recognize further that matters have gone so far in these regions that there is now no practical remedy for the evil, such as it is. They think, however, that there is yet time to regulate the output of carburetted water gas in this country. This is quite true. In order to confirm their faith, if possible, by the teaching of direct experiment, the Committee set Dr. Haldane to work; and the result is Appendix I. of the report. Dr. Haldane's computation of the expectation of fatalities from the general and exclusive substitution of carburetted water gas for coal gas is positively terrifying. We cannot discuss the appendix here, but are willing to admit the great value of the whole statement, regarded as a contribution to the literature of the subject. Our chief difficulty in accepting some of the writer's conclusions is that they are "in the air." To cite only two objections: First, it is a long way from being economically possible that carburetted water gas will completely supersede common coal gas in the United Kingdom; secondly, there should be no exception to any rule which brings out such tremendous results as that "the increase of about four times in the percentage of carbonic oxide is attended with an increase of about fifty or a hundred times in the probability of fatal accidents." What about Tottenham and Edmonton? Multiples and ratios are "kittle cattle" in the case of vital statistics.

We have only space left on the present occasion to deal with the recommendations; premising that we fully expected that something in the way of limitation and regulation of carburetted water-gas distribution would be suggested. These particular recommendations, however, will not stand criticism on the merits. To save repetition, we ask our readers to refer to this part of the report, as given in another column (p. 449), while we take the recommendations *seriatim*.

No. 1 is reasonable enough; but the point does not come within the range of practical gas politics.

No. 2 is a useless demand for the filling up of an empty form.

No. 3 is inane. There is all the difference in the world between setting up a carburetted water-gas plant and sending out the product. The suggested information might interest a few intending murderers and suicides; but even they might often be disappointed.

No. 4. All gas manufacturers keep full carbonizing accounts; but what information or benefit any gas consumer or ratepayer might be supposed to derive from looking at them, passes comprehension.

No. 5. Mere bureaucracy in the first part; impracticability in the main. What is "day" and what "night," as regards gas consumption?

No. 6. This would create intolerable interference and friction, if it could ever be worked.

No. 7 is unobjectionable.

The last recommendation is for the improvement of Coroners' inquests, which is badly needed all round.

It is not for us to suggest alternative restrictions and regulations; but the recommendations now in question spoil the report, which might otherwise be passed as an excuse for the printing of a valuable mass of evidence.

THE NAPHTHALENE EMPIRIC.

UNDOUBTEDLY the days of the empiric in gas manufacture are numbered. Slowly, but surely, the labours of keen observers, trained in methods of scientific research, are solving mysteries which the earlier generations of gas managers were compelled to regard as things surpassing their understanding. Let us not disparage the intellects of the men of the old school, who were indeed superior to their surroundings. But they were cumbered by the superstitions of an age in which children were universally taught that there were but four elements; and imbibing the spirit of that age they feared to probe too deeply the mysterious manifestations of natural laws. The quack reaped a golden harvest in fields which the therapeutist has since appropriated; and the empiric presented nostrums to industrial pioneers who would now resort to the technologist for information and advice. That age, so far as the gas industry is concerned, is not very remote, as those who care to recall the date when rational purification, for instance, was introduced, can testify; and, unfortunately, in some phases of gas manufacture, our knowledge is still for the most part empirical. The gas engineer too frequently has little or no leisure to devote to research; his time is fully occupied with the daily routine of manufacture and distribution. Our technical colleges do not direct the energies of capable pupils to the many eminently practical questions connected with gas making which still need investigation. Thus for years the naphthalene plague has been more or less fruitlessly discussed wherever gas managers have congregated; but few of them have attempted any serious research on the subject. Messrs. Botley's account, at the 1897 meeting of the Incorporated Institution of Gas Engineers, of their investigations at Hastings, was a complete revelation to many who had come to regard naphthalene as a perennial pest which must of necessity be endured. The interest excited by this communication is still fresh in the minds of readers of the "JOURNAL." Messrs. Botley were eminently practical; and their laboratory experiments—of which we think no detailed account was given—were but the precursors of extensive practical trials of the scheme which had most forcibly commended itself to them. Of the success which attended their trials, it is needless for us to speak now, since the details are so well known.

In another part of to-day's issue (p. 437) we are able to publish a translation of a paper by one of the disciples of Dr. Bunte, which is, we believe, the most valuable contribution to the solution of the naphthalene question which has appeared since Messrs. Botley presented their paper twenty months ago. It adds another debt to the many which the gas industry owes the Carlsruhe laboratory. One wonders when anyone of the mushroom crop of technical colleges and institutes in this country will present us with a similar series of valuable technical researches to those which have emanated during the past few years from the Carlsruhe High School. But while our own institutions remain comparatively speaking unprofitable, we may at least gain advantage by assimilating the fruits of the more fertile German laboratories.

Herr Eitner's treatment of the naphthalene question seems almost diametrically the reverse of Messrs Botley's method of investigation. He relies to the fullest extent on the laboratory, and does not attempt to make any practical application of whatever theories he may have conceived until he has proved their consonance or dissonance with experimental facts. To take one example. He wants a hydrocarbon which will dissolve naphthalene freely. There are plenty to his hand; but he is not content to use one haphazard, he must have the *best* solvent which fulfils certain other conditions. Here is opportunity—nay, occasion—for experiment; and he forthwith ascertains the degrees of solubility of naphthalene in a number of hydrocarbon liquids. He no longer has to surmise as to which liquid, *cæteris paribus*, will best suit his purpose, for he now knows indisputably. He deals with the vapour tensions of the liquids in a similar manner, and thus builds up a scheme for the prevention of naphthalene deposits which rests on a solid basis of experimental facts. If the scheme fails in practice owing to some unsuspected contingency or unrecognized collateral fact, the bulk of his labours is not lost, but remains as a substantial foundation for the subsequent elaboration of some more nearly perfect scheme. His method of research is sound, and is certain ultimately to lead to some successful issue.

It is not easy to say whether Dr. Eitner has so far achieved much more than the empiric of the past towards the practical removal of the naphthalene plague. His scheme, which involves the judicious carburetting of gas with solvent naphtha, needs to be tried on a working scale. There seems some uncertainty as to the grade of naphtha used; for solvent naphtha realizes a higher price than Dr. Eitner speaks of. Probably a crude coal tar naphtha is intended; but then such a liquid consists by no means chiefly of xylenes. On many points, Dr. Eitner is a very sound teacher. He will draw no distinction between the behaviour of naphthalene and other bodies on volatilization and condensation. Water—and, for that matter, snow also—volatilizes into the atmosphere; and similarly naphthalene may volatilize into gas. Aqueous vapour condenses from the atmosphere into water or snow; and similarly naphthalene vapour may condense from gas into solid naphthalene. Naphthalene vapour needs no special carrier; and steam—except in so far as it helps to maintain a higher temperature—does not account for the prevalence of naphthalene deposits. If he has done nothing more, Dr. Eitner has at least contributed to the overthrow of some baneful superstitions.

WATER BILLS FOR THE SESSION 1899.

(*Continued from p.* 365.)

THE Belfast Water Bill is to confer further powers on the Belfast City and District Water Commissioners. The boundary of the Commissioners' district of supply is to be extended so as to include certain town lands in the parishes of Shankill and Drumby, in the county of Antrim. New water-works are to be authorized, including new filter beds and pipe lines. The Ormeau Bridge, Belfast, is to be widened laterally in order to carry water-mains. An occupation road leading to, and extending along, the embankment of Middle South Woodburn reservoir in the parish of Carrickfergus, is to be stopped. Several clauses relate to the granting of easements. Additional lands are to be acquired for facilitating the construction of works and preventing the pollution of water. Lands may be grazed or let by the Commissioners. The period for compulsory purchase of land is put at seven years. A further water loan of £250,000 is required. Permission is sought for using the Antrim Road Works for recreative purposes. In the event of the formation of a superannuation fund by the Water Commissionners' workmen, a contribution from the water revenue of not exceeding one-fourth of the workmen's subscription is proposed.

The Burley-in-Wharfedale Urban District Water Bill is to empower the District Council to construct additional works comprising a reservoir to be situated on Carr Beck on Burley Common. Lands are to be acquired "together with all minerals and mineral rights, and all other rights and interests therein." The works are to be completed within seven years. Additional water capital to the amount of £12,000 is required.

The Bury Corporation Water Bill is to authorize the Corporation to acquire further drainage areas and appropriate the waters of the Whitewell Brook and the Black Carr Stream. It is proposed to borrow £243,000 for water-works purposes, and £160,000 for the purchase of the watersheds. The contemplated works comprise a reservoir on the Ogden Brook, in the parish of Haslingden, and a service reservoir at Slates, also in Haslingden parish. The works are to be completed within ten years. From and after the passing of the Act, no water for domestic purposes is to be supplied from the Holden Wood reservoir until the filter beds are completed. All water is to be filtered, under a penalty of £10 per day. In order to give a better supply to the higher parts of the borough of Haslingden, the proposed service reservoir is to be completed within two years. The local authority of any district supplied by the Corporation are to be entitled to take reasonable quantities of water from the fire plugs in their district for fire brigade practice once a month, at the price of 6d. per 1000 gallons. The rates for domestic supplies are to be increased to the extent of from £2 10s. to £1 13s. 4d. per cent. Money is to be borrowed for the redemption of water annuities.

The Derby Corporation Water Bill is to empower the Corporation of Derby to obtain a supply of water from the Rivers Derwent, Ashop, and Roe, and Burbage Brook. The proposed works comprise eight reservoirs in the higher watersheds of the Rivers Derwent and Trent, with service tanks and pipe-lines. Compensation water is to be discharged during the twelve hours of every working day from the reservoirs, besides a constant flow of one million gallons per day into the River Derwent. The works are to be completed within 20 years. Sheepwashing is to be regulated, and watering-places for cattle provided. When the Corporation are in a position to supply water in perpetuity to any outlying local authority in the county of Derby, such supply is to be given on demand for an annual payment equal to 4 per cent. on the capital outlay represented by the quantity, with an additional charge for maintenance and management. The population within the area of supply is to be entitled to a prior right to 25 gallons per head per day. Provision is to be made for the formation of water districts for taking a supply in bulk from the Corporation works. The County Council are to be empowered to promote Bills in Parliament with reference to these provisions. Under stated conditions authorities outside the county are to be entitled to a supply in bulk. For carrying out the scheme the Corporation seek to borrow £7,500,000, repayable in 100 years. The surplus profits of the undertaking are to be applicable to municipal purposes.

The Glasgow Corporation (Gas and Water) Bill contains clauses to enable the Corporation to borrow £250,000 additional water capital.

The Glastonbury Water Bill is to authorize the Corporation

to enlarge their water limits, subject to the proviso that the supply of the extended district is not to prevent the full and sufficient supply of the borough for domestic, trade, and all other purposes. The supply is to be constantly laid on under pressure of gravitation from the Edgarly reservoir. New works are to be constructed, including a well and reservoir in the parish of Pilton, to be completed within seven years. The rate for domestic supplies is to be 10 per cent. Metered supplies are to be charged not exceeding 2s. per 1000 gallons, with a minimum of 8s. per quarter. The Corporation desire to borrow £15,000 for water-works extensions, besides £3560 to pay off the existing debt.

The Leicester Corporation Water Bill is to enable the Corporation to carry out water-works extensions estimated to cost £4,144,000. The land is to be acquired within seven years. The works include several storage reservoirs in the parish of Hope Woodlands, Derbyshire, on the River Derwent, and other similar works for impounding the waters of the River Ashop. The catalogue of works is very extensive, and implies that Leicester seeks its new water supply in the same region as that to which the Bill of the Corporation of Derby applies. Local authorities whose districts are within ten miles of any aqueduct constructed under the Bill are to be entitled to a supply, after the borough and the present water limits have had 25 gallons per head, on paying 4 per cent. on the proportionate cost of the works. Provision is made for the constitution of a Joint Water Board, to be formed from the Corporations of Leicester and Derby, for dealing with such portion of the proposed undertaking as will lie north of the existing Derby water-works.

The Loughborough Corporation Bill includes a part relating to water supply. The district is to be enlarged, subject to the supply in the added region being made effective within six years from the completion of the reservoir authorized by the Corporation Act of 1897.

The Nottingham Corporation Bill contains a part relating to water. New works are to be constructed, comprising an extension of the existing Red Hill reservoir, and a covered reservoir at Greasley. The works are to be completed within seven years. The sum of £144,000 is required for water-works purposes.

The Nuneaton and Chilvers Coton Urban District Council Water-Works Bill is to enable the Council to make additional water-works, including wells and pumping stations in the parish of Nuneaton, to be completed within seven years.

The Otley Urban District Council Water Bill is to authorize the construction of a reservoir for impounding the waters of the Bow Beck, in the parish of Denton, and another on the March Gill in the parish of Middleton, in the West Riding. Compensation water is to be provided. The powers of supply of the Leeds Corporation in the district are to be extinguished. One of the reservoirs need not be completed for 20 years; but the remainder of the works are to be finished within seven years. The existing water-rates are repealed and a new scale is proposed, ranging from 7 to 5 per cent. The sum of £70,000 is to be borrowed for water-works purposes.

The Perth Water, Police, and Gas Bill contains a part relating to water. A new reservoir is to be made in the parish of Kinnoull, to be completed within seven years. The sum of £15,000 is to be borrowed for water-works purposes. Surplus water profits are to be applied to the reduction of the domestic water-rate.

The Rhondda Urban District Council Bill is to authorize the Council to construct a tramroad to enable them to carry out the Act of 1896 as regards the raising of the embankment of the impounded Lake Llynfawr. Wells and pumping stations in Ystradyfodwg parish are contemplated. The periods stated in the Act of 1896 for the acquisition of land and the execution of the authorized works are to be extended. The additional sum of £60,000 is required for water-works purposes, repayable in 45 years.

The Scunthorpe Urban District Gas and Water Bill is to authorize the Council to construct and maintain water-works for the supply of their district, comprising a pumping station in the parish of Scunthorpe, and a water tower in the same parish. The rates for domestic supplies are to range from 8 to 7 per cent., with the higher rate for inns. Metered supplies are to be charged a maximum price of 2s. per 1000 gallons. The sum of £25,000 is to be borrowed for water-works purposes.

The Sheffield Corporation (Derwent Valley) Water Bill is the third proposal to appropriate the waters of the Rivers Derwent and Ashop and their tributaries, this time in the prior interest of the Corporation of Sheffield. In 1896 the Corporation were empowered to take the waters of the River Porter, or Little Don, subject to the obligation to supply water in bulk to Doncaster and Rotherham. Further supplies are now needed; and inasmuch as a large portion of the watershed of the River Derwent is within the Sheffield water limits, the Corporation propose to go to this stream and the River Ashop for their additional supply. The scheme is estimated to cost £2,275,000. Three reservoirs are to be constructed on the Derwent, and a weir on the River Ashop. All pipes in main roads are to be laid along the sides. Provision is made for the formation of Joint Water Boards in the affected regions, and for raising capital under these agreements.

The Stockton and Middlesbrough Water Bill is to change the name of the Joint Board to that of the Tees Valley Water Board Certain powers conferred upon the Board in 1876 and 1890, for taking land required to construct an authorized reservoir, are to be revived. A new service reservoir is to be constructed within ten years. The Corporation of Stockton are to be empowered to borrow £153,460, the Corporation of Middlesbrough £184,152, and the Corporation of Thornaby-on-Tees £30,692. The charge for metered supplies is to be revised.

SUPPLEMENTARY WATER-MAINS FOR FIRE EXTINCTION.

In the "Journal" for the 25th of January last year (p. 173), we noticed at some length a report made by Mr. Foster Crowell to the Fire Department of the boroughs of Manhattan and the Bronx, New York City, on the question of having separate water-mains for fire-extinction purposes. Mr. Crowell, it may be remembered, visited Cleveland, Milwaukee, Detroit, and Buffalo, and secured the information and data concerning the character, dimensions, efficiency, and cost of the pipe-lines upon which his report was based, and which were summarized in the article above referred to. The subject has recently been reported upon to the New York Fire Department by the Chief (Mr. Bonner); and some extracts from his report have been published in the "Engineer." In addition to the particulars given by Mr. Crowell, Mr. Bonner furnishes some in regard to Boston, where at the time of the earlier report the system was being introduced. It appears there have been laid in that city, at considerable expense, about 4000 feet of extra heavy 12-inch cast-iron pipe, with improved fire hydrants attached about 200 feet apart, with two 3½ inch discharges, and a valve for each discharge. A separate tube is laid near the pipe-line for an electrical conductor, to be used in communicating between the boat and any part of the line. It will be used as a dry system during the winter season; but at all other times the pipe-line will be charged with fresh water, which will be maintained in position by the use of check-valves at either end. It has not yet been put in practical operation. It is laid with the intention of extending the system throughout the entire district, or where the fire risk is considered the greatest, in the near future.

Mr. Bonner states that, after a careful study of the fire-protection pipe system as now used by the above-named cities, there can be no question as to its practical utility, and as to its being the most economical auxiliary plant that any city could apply for its protection against fires. The streams of water that these pipe-lines can deliver is far greater in power than could possibly be obtained from many of the largest engines on land, and with a number of such lines well located on the front as well as on the rear of a fire, it would be safe to say that no fire could possibly extend beyond the effective points of the streams. These cities have taken advantage of a system that will prevent great conflagrations in the future by utilizing the power of the fire-boats that are usually lying idle during the progress of great fires in the hearts of their cities. It is stated that the system is so highly appreciated by the city authorities that they propose to continue adding to it yearly until dangerous sections of their cities shall be entirely encircled by the pipe-line system; and in one instance at least the system will be operated by a permanent pumping plant, located near the river front, which will work in conjunction with the fire-boat or relieve the boat at any time if it should be required elsewhere.

The defective point in the systems as now operated lies in the fact that, as now laid out, they have omitted to protect the roofs and rears of buildings, either of which positions during the progress of fires is just as important as the street in front of the fire. Great fires extend by the roof, and strip roofs of buildings hundreds of feet ahead of the seat of the fire, and generally follow the currents and direction of the wind. With this pipe-line extended to the roof, and continuing in a circuit round each block, with discharge-gates for hose connections at about every 200 feet or less, and with a main pipe to the roof connected with the underground system, or with an auxiliary pump located in the vicinity, ample protection would be afforded for the roofs and rears of buildings from the same system. It would also prevent the delay caused by hauling great quantities of hose to the roof, which otherwise must be done if it is desired to protect the roofs at any time during the progress of a fire. This is practically the only point of demerit in the pipe-line system; its continuance to the roof would be but a trifling additional expense, and would protect that part of a building which is so easily stripped and fired during the progress of great fires.

Mr. Bonner says there is no city better adapted for the use of the underground pipe system than New York, owing to its peculiar geographical lines. There are but few points where the total length would exceed 1½ miles; the city having an abundant supply of water on both sides. With a pumping capacity of 23,500 gallons per minute, which is rarely, if ever, used for fires in our commercial centres, there is no reason why this system should not be utilized to a greater advantage than in any of the cities now having such a system in use.

The fact must be realized that the capacity of land engines to force water to great heights has been reached. When greater power is required to force water to meet conflagrations, and to great heights, it must be obtained from other sources than the steam fire-engines now in use; and Mr. Bonner says there is no system that could better be recommended than the one under consideration. There are high buildings in New York to the upper storeys of which it is entirely beyond the capacity of

the machinery of the Fire Department to force water. It must also be considered that the tall buildings of the present day, as well as the mercantile buildings, are of greater height and cover larger areas than ever before, and that fires will entail great loss if not promptly checked. If the department is not able to control the fire and surround the structures with large quantities of water, there is a possibility that such fires will extend and become great conflagrations. This source of danger can be obviated by adding an auxiliary plant for the use of the department in the form of the underground pipe-line, connected to a roof-line system, as well as an aërial line, which should connect to all of the tall buildings. This should be fed from the underground system, and also from the city mains, with the aid of auxiliary pumps—electric or steam—located at different points in the city. By the use of the auxiliary pumps, water could be forced to the topmost storey of any building, no matter how high, as well as to the circuit on the roof-line; and this would afford positive protection against any extensive fire in that section of the city. Mr. Bonner shows how he proposes to apply the system in New York, and says it would be so arranged that connections could be made to the city water-works mains at any time.

OBITUARY.

The death took place on the 11th inst. of Mr. JOSEPH KETTLEBROUGH, who for upwards of 28 years had been Manager of the gas-works at Hedon, Yorkshire. He was in his 71st year.

A man who always exercised "a marked influence on both the religious and social life" of Swansea has passed away in the person of Mr. THOMAS PHILLIPS, J.P. Until failing health necessitated his retirement in 1892, he filled the position of Chairman of the Gas Company, and took more than ordinary interest in the development of their business. The deceased gentleman was 85 years of age.

PERSONAL.

Mr. W. H. PREECE, C.B., F.R.S., having last Wednesday attained the age of 65, retired from the position of Engineer-in-Chief and Electrician to the Post Office.

Although, as already mentioned in the "JOURNAL," Mr. ALFRED LASS has relinquished, on account of ill-health, the position of Secretary and Accountant of the Barnet District Gas and Water Company, his long connection with the undertaking will not be severed, as he has been elected to a vacant seat on the Board, caused by the death of Mr. W. Joslin.

Mr. JOSEPH CLAPHAM, of Keighley, has just been presented with an illuminated address in commemoration of his golden wedding, his eightieth birthday, and his forty-five years' connection with Spiritualism in that town. It bore testimony to Mr. Clapham's career as "a sterling and consistent champion of truth and principle," and his "great, generous, and, in all senses, beneficial" services to Spiritualism.

We regret to learn that, owing to advancing years and failing health, Mr. JOHN MACNIE, the Manager and Secretary of the Londonderry Gas Company, has been compelled to relinquish his position. Mr. Macnie has been in the Company's service for 32 years; and, in consideration of the valuable assistance he has rendered during this long period, the Directors propose that he shall be granted a retiring allowance equal to two-thirds of his salary.

NOTES.

Coal Storing and Handling Plant.

Mention has already been made in a "Note" of the chimney construction necessitated by the conversion of the New York tramway system to electric traction, as an illustration of the incidental results of such a change. Further particulars recently to hand respecting the progress of this mechanical conversion scheme emphasize the lesson. It is made apparent that electric tramway working upon the New York scale means the generation of electricity at stations that approximate to gas-works in respect of the quantity of coal to be housed and handled. At the new power station of the Third Avenue Railway Company, there is a dock entered from the Harlem River. Hither come the coal barges, which are dischaged by mechanical means; the coal being elevated and distributed into bins having a capacity of 10,000 tons. From these the coal slides down to feed the fires, passing on the way through automatic weighers, which record the weight consumed. The weight received must be otherwise ascertained. An interesting feature is the special provision made against fire. There is a fire-pump which forces water into a 14-inch main, provided with nozzles for the attachment of hose-pipes to bear upon the coal. The boilers are fired by Robey mechanical stokers, the hoppers of which are fed by the shoots leading from the automatic coal weighing machines. The output of the station is calculated at 100,000-horse power. This is to be delivered in the form of high-pressure alternating current to a number of rotary converter sub-stations, whence it will emerge, by means of the service mains, in the form of direct current at the voltage—550—found most convenient for working the motors on the cars. The extreme distance from the power station to the end of the main line is 12 miles.

Occluded Oxygen for Trade Purposes.

If a preliminary announcement by M. Jaubert to the French Academy of Medicine is borne out by future results, the range of employment of commercial oxygen will be vastly enlarged, and many remarkable industrial and other developments may be expected. The communication in question was of a rather mysterious character, and details are lacking; but it is explained that the preliminary notice was only intended to secure priority for the discoverer. M. Jaubert's claim is for having found a substance which, when used in the proper proportion, is capable of removing from the atmosphere of a closed chamber the carbonic acid, water vapour, and other irrespirable gases produced by a living animal enclosed in the chamber, while at the same time giving out automatically in exchange the mathematically exact quantity of oxygen required to maintain the normal quality of the air. Two experiments were exhibited by Dr. Laborde—one on a guinea pig under a bell jar, the other on M. Jaubert's brother, who wore a tightly-fitting respiratory mask. The demonstration seems to have been successful. The nature of the oxygen occluding substance is not mentioned; the only indication vouchsafed being that it is the lightest "reservoir" of oxygen in existence. It is stated that three or four kilogrammes of the substance is enough to keep a healthy adult alive for 24 hours in a space hermetically closed. If this is so, the value of the appliance in diving operations and rescue work in chemical factories and conflagrations will be inestimable. Dr. Laborde also suggests that the preparation will be of use in medicine, for dealing with cases of asphyxiation; since a few grammes, which could be carried in the waistcoat pocket, would at once yield several decalitres of pure oxygen. Indeed, the capabilities of the substance are difficult to define a limit to. A very few pieces of it placed in the galley of a gas-burner might yield a surprising effect.

Conditions of an Impulse Gas-Motor.

Among the many attempts that have been made to realize an impulse steam-motor, the Parsons steam-turbine is one of the most successful. More attention will be concentrated upon this type of motor when the new and improved Parsons turbine torpedo destroyers have approved themselves on the measured mile. It is understood that the obstacle to the application of the same principle to gas-engines lies in the physical impossibility of getting any material to stand the flame heat at which such a motor would have to work. It has been proposed, however, to cause the combustion gases at very high temperature and pressure to act in the first place upon, and impart their energy to, a body of some suitable heavy fluid at a high temperature, which would move at a much lower velocity, and in turn act upon a rotary motor or turbine. Upon this suggestion, Mr. Horatio Phillips writes in "Engineering" to say that the problem thus stated has been worked upon by himself with inconclusive results. He first tried driving a Pelton wheel by the energy of a jet of high-pressure steam allowed to expand to atmospheric pressure and a temperature of 212° Fahr. To obtain the best result, the buckets of such a wheel should be made to travel at one-half of the speed of the jet; but long before this speed was attained, the wheel, though made of spring-tempered steel, was destroyed by centrifugal force. Then was tried diluting the neat steam, so to speak, with several times its own weight of hot water pumped into it before it issued from the orifice of the pipe. Though the plan looked feasible on paper, it did not succeed. The question of an impulse motor for steam or combustion gases is resolved by Mr. Phillips into this: If a Pelton wheel could be made strong enough to stand the necessary speed of revolution, a large proportion of the energy in the undiluted jet could be converted into mechanical power. With the jet diluted, the Pelton wheel could run at its proper speed; but as the pressure on the buckets cannot be more than that given by the undiluted jet, and as the speed of buckets would be comparatively low, there would be a great loss of energy.

Manchester District Institution of Gas Engineers.—The annual meeting of the Institution will be held next Saturday, at the Grand Hotel, Manchester, under the presidency of Mr. W. S. Haddock, of Warrington. The first item in the long programme of proceedings issued by the Hon. Secretary (Mr. S. S. Mellor, of Northwich) is a visit to the Gaythorn gas-works of the Manchester Corporation, where, by permission of the Chairman and members of the Gas Committee, an installation of coke-conveying, &c., machinery, as applied to inclined retorts, will be inspected. After luncheon, at the Grand Hotel, the business of the meeting will be transacted. This will comprise the presentation of the report and accounts, the election of two Vice-Presidents and the office-bearers for the current year, and also two new members. The President-Elect (Mr. R. G. Shadbolt, of Grantham) will then be introduced, and deliver his Inaugural Address. Mr. J. H. Brearley's paper on "The Balance-Sheet," read at the last meeting, will be discussed; and this will bring the business to a close. The members will afterwards take tea together as usual.

COMMUNICATED ARTICLE.

THE FLASH-POINT OF BURNING OILS.

By Alexander Robertson, of Peebles, N.B.

In view of the interest that is at present being taken in prospective legislation regarding the fixing of what should be the flash-point of lamp oils, it may be interesting and instructive to direct attention to some of the physico-chemical conditions having a more or less direct bearing upon the subject.

To make plain the train of thought which suggested the writing of this article, it is necessary to start with some truisms which may help to put the reader and the writer in the same state of mind to examine impartially this vexed question. The object aimed at in fixing the flash-point of lamp oil is to secure a reasonable degree of safety from explosion and fires—more particularly the former. It is evident that to ensure this reasonable degree of safety, the lamp oil must not give off vapour so as to form an explosive mixture with the air at a temperature such as that to which it may be subjected when used for domestic illumination. The conditions which influence the temperature of oil in the lamp are various, but may be conveniently defined as three: (1) Those arising from conditions external to the lamp, such as the temperature of the atmosphere in the place or room where the oil is used, or to the heat which may be radiated or convected from the fire-grate. (2) Those due to the construction of the lamp, such as the conduction of heat from the flame of the burning oil by the metal-work to the oil in the lamp fountain, or radiated heat from reflectors. (3) The difference in the heat that may be transmitted to the oils in the lamp fountain due to a difference in the molecular structure or constitution of the oils themselves.

All these conditions have received attention. The first and the second have been fairly well determined and fully taken into consideration in fixing what would appear to be such a flash-point as would ensure reasonable safety. It is very doubtful, however, if the third set of conditions has received the scientific investigation it deserves, as it would appear from recent lamp accidents that oils having like flash-points are very far from possessing a like degree of safety. In illustration of how the difference comes about, reference may be made to the knowledge recently acquired regarding equivalent differences in the combustion of illuminating gases.

The gases acetylene, ethylene, and ethane all contain the same quantity of carbon in the molecule, only combined with different proportions of hydrogen; being members of three important homologous groups of hydrocarbons. Carbon is, as is well known, the element which emits the light during the burning of a hydrocarbon; yet the same quantity of carbon contained in these gases, instead of emitting anything like the same equivalents of light, emit light in the enormously different proportions of 250, 68, and 35 candles respectively. The question naturally suggests itself how such a result comes about. Recent investigation has shown that the result is due to heat energy locked up in these respective compound gases, and to the manner in which this heat is given out in process of combustion.

Acetylene has locked up in its molecules a quantity of heat energy largely in excess of that which would be given out by the combustion of its constituent elements separately. This locked-up heat energy is rapidly and locally evolved at the instant of decomposition; and the heat given out is so quickly transmitted from molecule to molecule that decomposition is apt to take place even in the jet through which the acetylene passes to the flame, with the result that carbon may be deposited there and give trouble. Ethylene also has stored up in its molecules a considerable amount of heat in excess of that which would be given out by its constituents, carbon and hydrogen, but much less than in acetylene. The heat evolved during its combustion is neither so rapidly nor so locally given out as in the case of acetylene; and there is therefore less tendency for the burner to become heated, or decomposition to take place in the jet of the burner. The stored-up heat is, however, given out in the body of the flame; bringing about decomposition, and setting free the carbon, and emitting still a considerable amount of light. Ethane, on the other hand, has not such heat stored up in its molecules, but rather contains less than that which would result from the combustion of its constituent elements separately; and the combustion is still less rapidly and locally carried on, and at a considerable distance from the burner, where decomposition takes place, and where luminous carbon takes its part in giving out light with little or no transmission of heat to the burner.

Now similar differences obtain in the case of lamp oils, due to the difference in their constitution. The largest proportion of American mineral lamp oils are mainly composed of paraffins belonging to the same group of hydrocarbons as the ethane gas; and they therefore develop the least amount of heat locally. The paraffins being also easily decomposed at comparatively low temperatures, and capable of decomposition into equivalents of simpler paraffins and olefines, with the absorption of heat and without the deposition of solid carbon, are the cleanest as well as the coolest burning of all lamp oils.

The Scotch lamp oils are mainly composed of the paraffin and olefine groups of hydrocarbons; and for the reasons just explained, they also burn without developing much local heat, and burn both fairly cool and clean. But there are many other lamp oils—such as some of those from Russia—in which the paraffins are practically absent, but which are composed of other series of hydrocarbons of much higher specific gravities, which cannot be decomposed or cracked up without the deposition of carbon, and which develop considerably more local heat than the other lamp oils composed mainly of the paraffin group or a mixture of the paraffin and olefine series of hydrocarbons. They consequently burn neither so cleanly nor so cool. As with illuminating gas, so with oil—that which burns cooler gives least light per unit quantity. But the public prefer such oils; and on this account American oil commands a higher price than other less clean and cool burning oils, though possibly less safe. The constitution of lamp oils is further liable to great differences due to defective refining, and it may be in some cases wilful manipulation during the process—more particularly in the fractional separation of the oils by distillation.

It is evident that, before an oil can be burned, it must first be volatilized and pass into the state of vapour; and that therefore the temperature of the oil on the surface of the lamp-wick must be above the volatilizing point of the oil. As a consequence it follows that, other conditions being the same, the temperature of the burner should rise as the temperature at which the oil volatilized rises. At first sight, it might appear that the result of raising the flash-point—which is practically equivalent to raising the boiling-point—would necessarily involve a rise in the temperature of both wick and burner, and that thus the advantages of raising the flash-point would to a great extent be nullified. But we have already seen that there are other conditions which may be present, having a material influence in modifying the heat evolved at the point of ignition. This, however, is not all. Lamp oils derived from petroleum or from artificial paraffin oils, consist of a series of hydrocarbons gradually rising in specific gravity and in their boiling-points. A good honest lamp oil consists of a cut from the distillate consisting of the whole series suitable for illuminating purposes, with light naphtha and heavy oils excluded. Now with such an oil it does not follow that the raising of the flash-point necessarily involves a greater development of heat in the burner. It will altogether depend upon the constitution of the oils, and what means are employed in raising the flash-point.

The volatilizing point of a homologous series of hydrocarbons from the surface of a lamp-wick is, at first, that of the most volatile of the series. But as each successively less and less volatile portion evaporates, the temperature rises, till every member of the series is evaporated simultaneously, as they are brought forward by the capillary action of the wick and under the heat influence of the flame. If the sole condition operating in determining the temperature of the wick and burner was the volatility of the oil, the temperature would be the mean of their respective volatility. We have seen, however, that with the paraffin group of hydrocarbons, they are easily decomposed. Indeed, they decompose at their temperature of evaporation; and this is more particularly the case with the higher and less volatile paraffins. As heat is absorbed in the cracking-up process, the temperature of the wick and burner is thus kept lower than it would otherwise be; and therefore lamp oils mainly composed of paraffins do not necessarily develop more heat in the burner as the flash-point rises. Therefore, the petroleums mainly composed of paraffins are made safer in proportion as the flash-point is raised. Besides, if the flash-point is raised as it should be by fractionating out a portion of both the most and least volatile of the paraffines, the mean volatilizing temperature from the surface of the wick would not be much altered either way. A similar set of conditions obtains with properly fractionated oils composed of mixtures of paraffins and olefines, as is the case with Scotch oils.

The conditions are very different in the case of oils which decompose with the evolution of carbon comparatively close to, or in the surface tissue of, the lamp-wick, due to their molecular structure (as already explained), to defective chemical treatment, or to the intentional method in which the oils have been fractionated. In such cases, a large amount of local heat is evolved, which is much in excess of that necessary for evaporation. This excess of heat is dissipated in all directions; and there have been instances in which the lamp-burner fittings have been quite destroyed, and the contents of the fountain fired.

It is evident, therefore, in fixing a flash-point, that it would be impossible to fix it so as to render the latter class of oils reasonably safe, without unnecessarily increasing the cost to the public, and causing unnecessary loss to the class of lamp-oil producers who had naturally clean and cool burning oils, and who had put them upon the market after honest fractionation and careful chemical treatment. Very similar remarks apply to lamps. Just as the demand for low-priced oils has induced the toleration of low-flash point and impure oils, and made the Government reluctant to impose restrictions, so it is with lamps. There is no doubt that badly constructed, flimsily got-up lamps have been as much to blame for accidents as faulty oils. Though this may be the case, however, there must be some standard of flash-point; and while it would be unfair to fix a standard that would press with undue hardship upon the consumer or the producer, yet both commercially and in the interests of public safety the standard should be so high as to make oils reasonably safe under the conditions which must be unavoidably present at certain times, and under common circumstances, during their use.

The present flash-point is 73° Fahr. It is evident that such a flash-point is too low, even for the highest class of oils, as climatic conditions alone are on many occasions such as to raise the oil to the explosive point; and however cool burning the oil may be, and however well constructed the lamps, some heat must pass from the luminous flame by radiation, if by nothing else, to the oil in the fount. It therefore seems evident that the flash-point should be raised, so that with care, and under the best conditions, there should be a desirable and reasonable amount of safety attending the use of an article that has become a necessity.

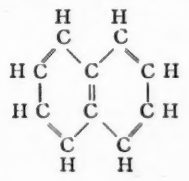
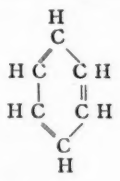
TECHNICAL RECORD.

THE NAPHTHALENE QUESTION.

The following is an abstract-translation of a paper on this subject by Dr. P. EITNER, of Carlsruhe, read before the Mid-Rhenish Association of Gas and Water Engineers. The text of the paper has been given in the "Journal für Gasbeleuchtung."

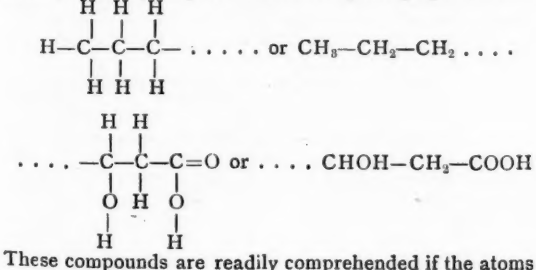
The researches of which an account is given in this paper were undertaken at the instigation of Dr. Bunte, and were carried out in the laboratory of the technical college at Carlsruhe. The results indicate primarily how existing naphthalene deposits may be removed; but they also afford the basis of a scheme for the prevention of the occurrence of naphthalene stoppages. The naphthalene trouble has already evoked a number of similar investigations, among which may be cited some recorded in 1891 by Herren Kunath and Hasse, and others, also of that year, by Dr. Bunte. In place, however, of taking these researches as a starting point, it may be more convenient to recapitulate briefly the results so far obtained.

Naphthalene is a hydrocarbon of analogous constitution to benzene, as is apparent from the annexed graphic formulæ—

Naphthalene ($C_{10}H_8$).	Benzene (C_6H_6).
	

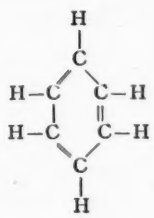
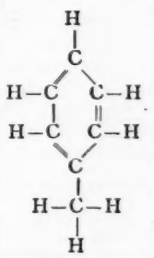
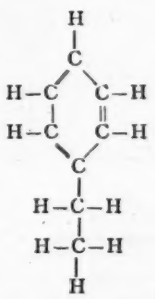
Thus benzene is of simpler constitution than naphthalene. Benzene is a liquid of aromatic odour, which solidifies to crystals at 6° C. (43° Fahr.), and boils at 80° C. (176° Fahr.). Naphthalene has larger and heavier molecules, which are richer in carbon. It is a solid at ordinary temperatures; it melts at 80° C. (176° Fahr.), and begins to boil at 217° C. (423° Fahr.). Like benzene, however, it volatilizes at ordinary temperatures, and forms naphthalene vapour, just as water evaporates and yields aqueous vapour at the prevailing temperatures. Both naphthalene and benzene occur in very varying amount in illuminating gas; and the question at once arises, At what stage in the manufacture do these bodies arrive in the gas? A definite answer can be given to this question. Both practical research and theory show that neither benzene nor naphthalene can be produced in the cold from the constituents of the finished coal gas. Gas from which benzene and naphthalene have been completely removed, remains free from them. The crude gas as it leaves the retort contains them, however; and consequently they must be formed in the retort during the gasification of the coal. They are formed by heat at the same time as the other gaseous constituents.

The next question is how the benzene and naphthalene arise in the gasification of the coal; and this remains as yet unsettled. Gasification is essentially a destructive process, of which our conceptions may be stated thus: The molecules of the coal substance are undoubtedly of very complex composition. They consist of a great number of atoms of carbon, which are linked to one another after the manner of a chain, and are combined with atoms of hydrogen, and in some cases with atoms of oxygen and nitrogen also. Such chains are to be found in cellulose or wood fibre, in the fatty acids, and many other organic substances; and they may be illustrated by the graphic formulæ—



These compounds are readily comprehended if the atoms are regarded as small bodies imbued with life, and possessed of arms with which they can lay hold of other bodies. The carbon atom has four arms, the hydrogen atom only one, and the oxygen atom two. Chemical compounds are formed by the atoms mutually seizing and holding one another by their arms. But in addition to the "open" chains illustrated above, in which there are free ends, there are also to be found in the coal substance chains in which the initial and final members are united to one another, so that rings are formed, such as are illustrated in the formulæ for benzene and naphthalene. Bodies having ring formulæ display different properties from open-chain substances.

One or several lateral chains can be attached to single carbon atoms in the case of substances of either ring or open-chain formula. Thus there are obtained new substances which are described as "homologues" of the substance from which they arise. For instance, toluene and xylene are homologues of benzene, as is shown by the graphic formulæ:—

Benzene.	Toluene.	Xylene.
		

When coal, of which the molecules are represented by such rings and chains, with lateral chains, is subjected to strong heat in the retorts, vigorous movement and concussion take place among the molecules; for heat itself is but molecular movement. The molecular chains are hurled about, rebound on, and pound one another the more vigorously the higher the temperature to which they are exposed. The long chains are thus ruptured into fragments, which may be partly separate members and partly their elementary constituents. The arms of the atoms which are set at liberty seize the free arms of other atoms; and thus, from the heavy unwieldy molecules of the coal substance, result fresh smaller and more mobile molecules, which constitute the new substances which are found in coal-gas and the bye-products. The ring-shaped structures are far less readily ruptured in the general destruction, as by their constitution they are more firmly held together than are the open chains. Thus it happens that such ring-shaped structures, notwithstanding their relatively large and unwieldy molecules, are preserved in considerable quantities. But the attached lateral chains are partially torn off, or are abbreviated; and benzene, naphthalene, and similar bodies, such as anthracene, and their more simple homologues, remain, and mingle as vapour with the gaseous products.

By such phenomena there is produced coal gas, which is chiefly a mixture of hydrogen, methane, ethylene, carbonic oxide, carbonic acid, and benzene vapour. The higher homologues of benzene, of naphthalene and its homologues, anthracene, and other substances, on account of the magnitude of their molecules, are by no means readily volatile. They condense as soon as the gas is cooled, and, mixed with soot, form the tar. The coke which remains in the retort consists (apart from the mineral constituents or ash in the coal) chiefly of carbon, which is split off from the molecules in the course of the decomposition of the coal substance, and is non-volatile. Coke contains also some particles of the original molecules; the quantity of these being greater the less thoroughly the coal was gasified. In addition to these three chief products of gasification, there are formed also small quantities of water, ammonia, cyanogen, and sulphuretted hydrogen. Such are roughly the chief features of the process of gasification. The quantitative relations of the different components of coal gas and of the coal which is gasified, are shown in the following table, which gives mean values. Variation of the description of coal and the method of gasification, will cause deviations from these figures.

TABLE I.—*Coal Gas.*

—	Composition.		One Cubic Foot of Gas contains	100 Parts by Weight of Coal yield
	Percentage by Volume.	Percentage by Weight.		
			Grains.	Parts.
Hydrogen (H_2) . .	47·0	7·4	18·4	1·26
Methane (CH_4) . .	34·0	42·8	106·2	7·29
Carbonic oxide (CO) .	9·0	19·9	49·4	3·39
Benzene (C_6H_6) . .	1·2	7·4	18·4	1·26
Ethylene (C_2H_4) . .	3·8	8·4	21·0	1·44
Carbonic acid (CO_2) .	2·5	8·6	21·4	1·47
Nitrogen (N_2) . . .	2·5	5·5	13·5	0·93
	100·0	100·0	248·3	17·04

But even of greater significance than the above table for our present purpose, is the subjoined statement of the quantities of the chief products obtained by the gasification of 100 parts of coal, and of the quantities of benzene and naphthalene formed, and their distribution among the chief products. Finally, there are appended the amounts of the vapours of benzene and naphthalene which 1 cubic foot of gas and the gas from 1 ton of coal can retain at 10° C. (50° Fahr.).

TABLE II.

100 parts by weight of gas coal yield—

Coke	68 parts	
Water (gas liquor)	10 ,,	
Tar	5 ,,	(containing 6 per cent. = 0·3 part of naphthalene)
Coal gas	17 ,,	(containing 8 per cent. = 1·4 parts of benzene)

There are thus obtained from 100 parts by weight of coal 1·3 parts of benzene, distributed thus—

1·25 parts = 96·2 per cent., in the gas.
0·05 parts = 3·8 per cent., in the tar.
1·30 parts = 100 per cent.

and 0·3 part of naphthalene distributed thus—

Traces = — per cent., in the gas.
0·3 part = 100 per cent., in the tar.
0·3 part = 100 per cent.

Coal gas at 10°C (50° F.) retains—

	Per Cubic Foot.		Per 10,765 Cubic Feet (1 ton of Coal, at 30 Cubic Metres of Gas per 100 kilos.)
Benzene	94·8 grains	..	146 lbs.
Naphthalene	0·87 ,,	..	1 lb. 5½ oz.

The above are, of course, only approximate values in round numbers. It is specially noticeable that almost the whole of the benzene is found in the gas, and that only about 3·8 per cent. is in the tar. Conversely, there are normally only traces of naphthalene in the gas, and nearly the whole of it passes into the tar. The proportions in which the benzene is distributed between the gas and the tar are less striking because the gas is capable of retaining considerably more benzene than results from the gasification of the coal. It is otherwise with naphthalene, for more is produced than the gas can retain; and therefore we should expect that the gas must always be saturated with naphthalene vapour. But actually there are normally found only traces of naphthalene in the gas. Some influence must therefore be at work which withdraws naphthalene from the gas to the tar. The cause lies in the solvent power of the constituents of the tar for naphthalene. Chief among these constituents, may be mentioned the homologues of benzene, which have ring formulæ with lateral chains attached. These compounds dissolve naphthalene freely, and remove it from the gas while they are condensing to tar, and, in the form of a tarry mist, are in intimate contact with the gas. Obviously the removal of the naphthalene from the gas will be so much the more thorough the more such tarry mists are found in the gas owing to condensation, and the longer and more intimately the crude gas is brought into contact with these mists. Hence the important inferences may be drawn that the homologues of benzene must not be destroyed by too high a heat in the retorts, and that condensation must be both slow and abundant. Therefore a few water condensers, which act very vigorously, and rapidly bring the gas to a low temperature, do not suffice to remove the naphthalene from it. It is much more to the purpose to cool the gas slowly at first to the outer temperature in large atmospheric condensers, and then further to reduce its temperature by means of water condensers. The rule which experience has taught—that good and abundant condensation is the best means of avoiding naphthalene stoppages—is thus substantiated.

But gas-works are frequently not in a position to have their condensing plant such as this fundamental rule demands. Consumption increases, and the claims on the gas-works grow; and it is sought to make existing plant suffice as long as possible, with the result that more is required of it than it is capable of. If in this manner the condensing plant proves inadequate for the increased consumption, small quantities of naphthalene will remain in the gas, and will be deposited in the apparatus and distributing system wherever the conditions are favourable to the deposition of naphthalene. In order to avoid naphthalene stoppages under these conditions, attempts have been made to hinder the formation of naphthalene in the retorts. But clearly these schemes are useless, for a consideration of the quantity of naphthalene which is normally formed in the retort, and the small proportion in the gas which suffices to produce stoppages, will convince us that nothing would be gained if the quantity of naphthalene formed were reduced to less than one-half the normal quantity. It has also been imagined that the steam or the ammonia in the gas acts as a special carrier of naphthalene, and that naphthalene stoppages would vanish if the gas were completely dried or the ammonia entirely removed. But Kunath's researches showed that neither aqueous vapour nor ammonia was the cause of naphthalene stoppages. This conclusion might have been foreseen, for the vapour of naphthalene behaves like any other vapour, and requires no special carrier. On this account, also, experiments aiming at the removal of naphthalene from the gas by the addition of other vapours (benzoline, &c.) have proved fruitless.

In order to find a rational method of combating naphthalene stoppages, we must consider in the first place what are the conditions which would cause the deposition of naphthalene from the gas. Naphthalene exists in the gas as vapour—just as water occurs in the atmosphere as aqueous vapour. The behaviour of the naphthalene in gas resembles that of aqueous vapour in air. If the air is saturated with aqueous vapour at a certain temperature—say, 20° C.—this temperature is the dew-point of the air. If the temperature of the air falls below the dew-point, dew or rain is produced by the separation of the water from the air; for the air is capable of retaining more aqueous vapour as the temperature rises, and less as it falls. If the dew-point is below the freezing point—say, — 2° C.—the air is saturated with aqueous vapour at that temperature; and if it is cooled to a lower temperature, water will be separated from it—no longer, however, as a liquid, but in the solid form as hoar-frost or snow. Exactly the same conditions obtain with the naphthalene in gas. If the gas contains as much vapour of naphthalene as it can take up at (say) 10° C., then the naphthalene dew-point for this gas is 10° C., and naphthalene will be separated from it if the temperature falls below 10° C. As this separation occurs at a temperature below the melting-point of naphthalene, the substance separates in the solid state. Moreover, as naphthalene crystallizes very readily, the well-known voluminous scaly or laminated crystals are formed, and soon fill and stop up the main. Naphthalene deposits and stoppages therefore occur only in those parts of the apparatus and mains at which the temperature is lower than the naphthalene dew-point.

But the naphthalene only separates in crystalline laminæ if it is deposited alone in the pure state. If liquid hydrocarbons, all of which dissolve naphthalene very freely, are separated along with it, then the naphthalene is dissolved as it condenses, runs away with the liquid condensation to the nearest syphon, and causes no stoppages. These facts indicate the courses which must be pursued to avoid naphthalene stoppages, and to remove deposits of naphthalene.

The vapour of a good solvent for naphthalene, which will separate when the gas is cooled along with the naphthalene, must be imparted to the gas in sufficient quantity for the solution of the deposited naphthalene. This carburetting of the gas can be applied either on the works to the whole of the gas made, in order to avoid naphthalene stoppages, or locally so as to get rid of existing naphthalene deposits.

But in order that the treatment of the gas in this manner may prove practicable, the carburetting liquid which is imparted to the gas must fulfil four conditions—viz.: (1) It must have a very great solvent action on naphthalene. (2) The quantity of liquid required to be used must be as small as possible. (3) The illuminating power of the gas must not be appreciably affected by it. (4) Its price must be so low that the cost of the process is not excessive.

The following solvents for naphthalene were examined, to see to what extent each fulfilled these conditions: Alcohol; petroleum ether, boiling between 80° and 90° C. (176° and 194° Fahr.); benzene, boiling between 80° and 84° C. (176° and 183° Fahr.); toluene, boiling between 110° and 112° C. (230° and 234° Fahr.); and xylene or solvent naphtha, boiling between 135° and 140° C. (275° and 284° Fahr.). The solubility of naphthalene in these liquids at different temperatures was first ascertained, with the results shown in Table III.

TABLE III.—*Solubility of Naphthalene at Different Temperatures.*

Solvent.	Parts by Weight of Naphthalene Dissolved by 100 parts by Weight of the Solvent.	
	At 10° C. (50° F.)	At 0° C. (32° F.)
Alcohol	5·00	4·25
Petroleum ether	11·05	7·75
Benzene	40·70	32·00
Toluene	35·30	24·80
Xylene	29·00	20·80

The best solvent therefore is benzene. Before deciding in its favour, however, we must consider how much of each liquid must be added to the gas to saturate it, and how much is separated again on cooling, and is thus available for dissolving naphthalene. The carburetting liquid only acts as a solvent of naphthalene if it separates out again as a liquid. As vapour, it does not dissolve naphthalene. The tension of the liquids, or the pressure which they exert at different temperatures in order to pass over into the gas as vapour, was investigated, with the following results:—

TABLE IV.—*Tension at Different Temperatures in Millimetres of Mercury.*

	At 0° C. (32° F.)	At 10° C. (50° F.)	At 20° C. (68° F.)
Alcohol	12·0	20·0	43·0
Petroleum ether	53·0	69·0	100·0
Benzene	25·0	49·0	76·0
Toluene	8·5	14·0	23·0
Xylene	3·0	4·2	7·0

From these figures may be calculated the quantity of each

liquid which 1 cubic foot of gas takes up in order to become saturated with its vapour.

TABLE V.

—	At 0° C. (32° F.)	At 10° C. (50° F.)	At 20° C. (68° F.)
	Grains.	Grains.	Grains.
One cubic foot of gas takes up of—			
Alcohol	16·02	22·37	47·46
Petroleum ether	137·90	173·71	247·17
Benzene	50·78	94·65	145·39
Toluene	20·32	31·79	51·89
Xylene	7·38	11·06	18·35

If the gas is saturated with the vapour at 20° C., then on cooling to a lower temperature the liquid separates out until the limit of saturation at the lower temperature is attained. The liquid which separates is available for dissolving deposited naphthalene. Any liquid which remains as vapour in the gas is wasted so far as the solution of naphthalene is concerned. The following table shows the relations for the different liquids and temperatures:—

TABLE VI.

—	Grains of Liquid which Separate from 1 Cubic Foot of Gas when it is Cooled.			Grains Retained as Vapour at	
	From 20° C. to 10° C.	From 10° C. to 0° C.	From 20° C. to 0° C.	10° C.	0° C.
Alcohol	25·09	6·35	31·44	22·37	16·02
Petroleum ether	73·46	35·81	109·27	173·71	137·90
Benzene	50·74	43·87	94·61	94·65	50·78
Toluene	20·10	11·47	31·57	31·79	20·32
Xylene	7·29	3·68	10·97	11·06	7·38

From these figures and the table of solubility of naphthalene in the liquids (Table III.), we can calculate how much naphthalene can be dissolved by the quantity of each liquid which separates from 1 cubic foot of gas when it is cooled through a given range of temperature.

TABLE VII.

—	Grains of Naphthalene Dissolved by the Quantity of Carburetting Liquid which Separates from 1 Cubic Foot of Gas when it is Cooled.		
	From 20° C. to 10° C.	From 10° C. to 0° C.	From 20° C. to 0° C.
Alcohol	1·25	0·27	1·34
Petroleum ether	8·12	2·78	8·47
Benzene	20·65	14·04	30·28
Toluene	7·10	2·84	7·83
Xylene	2·11	0·76	2·28

Next it is easy to calculate how many cubic feet of carburetted gas must be cooled so as to yield by condensation the quantity of the solvent which will dissolve 100 grains of naphthalene.

TABLE VIII.

Gas Carburetted with	Cubic Feet of Carburetted Gas needed to Effect the Solution of 100 Grains of Naphthalene when the Gas is Cooled.	
	From 20° C. to 10° C.	From 20° C. to 0° C.
Alcohol	79·18	74·79
Petroleum ether	12·31	11·81
Benzene	4·85	3·30
Toluene	14·10	12·77
Xylene	47·37	43·85

Finally, from these figures and the figures given in Table V. of the quantity of liquid taken up by the gas, it is easy to calculate the quantity of liquids with which the gas must be saturated at 20°C, in order that 100 grains of deposited naphthalene may be dissolved by it.

TABLE IX.

—	Grains of Liquid with which the Gas must be Saturated at 20°C, in order that 100 Grains of Naphthalene may be Dissolved when the Gas is Cooled.	
	From 20° C. to 10° C.	From 20° C. to 0° C.
Alcohol	3758	3549
Petroleum ether	3044	2919
Benzene	705	479
Toluene	732	663
Xylene	869	804

Assuming that the carburetting liquids are obtainable at the prices named, the cost of the process per 100 grains of naphthalene dissolved is shown in the following table:—

TABLE X.

—	Price per Pound.	Price per Gallon (say).	Cost of the Process per 100 Grains of Naphthalene Dissolved, when Gas is Cooled.	
			From 20° C. to 10° C.	From 20° C. to 0° C.
	d.	s. d.	d.	d.
Alcohol	1·744	1 2	0·936	0·884
Petroleum ether	1·907	1 1	0·829	0·795
Benzene	1·090	9½	0·110	0·075
Toluene	1·526	1 1½	0·160	0·1 4
Xylene	0·545	4¾	0·067	0·063

At these prices, therefore, xylene (solvent naphtha) is the cheapest agent for use. Coal gas, however, always contains appreciable quantities of the vapours of homologues of benzene—such as toluene and xylene—and so it is not necessary to use the full quantity required according to the calculations in order to secure the desired effect. Thus the xylene process proves even cheaper than is indicated above. The quantity of xylene that must be used per 1000 cubic feet of gas cannot be stated universally, for it varies according to the conditions of manufacture, the condensation effected, and other circumstances. It must be ascertained by trial. As a rule, 8·75 grains of solvent naphtha per cubic foot of gas, or 1¼ lbs. per 1000 cubic feet, will suffice. Step by step the quantity used should be diminished, until what is just sufficient has been ascertained.

But it is not only on account of its cost that the solvent naphtha process proves the most rational one. From Table VI. it will be seen that less xylene remains in the gas after cooling than of other agents. The quantity which remains is so small that it cannot affect the illuminating power of the gas; but such is not the case with petroleum ether, benzene, and toluene. So much of these agents is retained by the gas that its flame becomes enlarged, and is rendered smoky thereby. They do not comply with the third of the four requirements laid down. The researches now recorded indicate that carburetting gas with solvent naphtha is at once the most rational and the cheapest means of avoiding or getting rid of naphthalene stoppages.

In order to apply the process to local deposits of naphthalene, the solvent naphtha is poured through a hole in the main shortly before the deposit, so that the gas when charged with the vapour of the naphtha passes over the deposit. Then the solvent naphtha will condense in any place where cold causes the naphthalene to condense, and will get rid of any stoppage. If the gas is carburetted at the works, in order to avoid deposits of naphthalene the carburetting should be carried out in the warm, in the same manner as gas is carburetted with benzene; but the carburetting plant can be much smaller than that used for benzene.

NERNST'S ELECTRIC LIGHT.

In the last number of the "JOURNAL," we gave the text of the paper on the above subject read by Mr. James Swinburne at the Society of Arts on the 8th inst. It gave rise to an interesting discussion, the chief points in which are noticed below.

The first speaker was Professor Ayrton, F.R.S., who congratulated Professor Nernst on having achieved the wonderful result of rendering an insulator conducting by simply heating it, and also the author of the paper on the way in which he had brought the subject before the meeting. The knowledge that an insulator could be made to conduct electricity by heating it was much older than the recent experiments of Sir W. Roberts-Austen; for some twenty-three years ago a paper appeared in the "Transactions" of the Royal Society on the subject of the extraordinary diminution of resistance in a solid electrolyte by heating. It had also been known ever since carbon filament lamps had been on the market that there were certain difficulties connected with them, and many experiments had been made, and patents taken out, with the object of using refractory earths. But no one before Professor Nernst had apparently thought of the simple expedient of heating a very good insulator with a match or spirit lamp, applying a current of suitable potential, and thus obtaining a brilliant light. This result was clearly of enormous commercial importance, and would be an entirely new departure in glow-lamp electric lighting. It was also extremely interesting from the purely scientific side, as it touched on a question which Mr. Swinburne had passed over rather lightly, as though only a few foolish people fancied there was something in the Welsbach mantle which they did not entirely understand. This invention showed that illuminating gas was not necessary for obtaining light by incandescence from the rare earths. Some few years ago he endeavoured to ascertain if any report had been made throwing light on the question whether the effect of the Welsbach burner depended solely on the high temperature; and he found a reference to a German paper in which experiments were quoted which seemed to show that the high temperature was not the sole factor. Subsequently he discussed the matter with a distinguished English chemist, who fully agreed in the view that it was not solely a question of

temperature; and more recently he again discussed it with Professor Elihu Thomson in America, who took exactly the same view. Many people thought that the material of which the mantle was made absorbed oxygen from the air or the gas, and compressed it, much as spongy black absorbed hydrogen and oxygen, and so caused these gases to burn under considerable molecular pressure. It was not merely that the bunsen flame raised the material to a high temperature, but that the gas and air were compressed together in the pores of the material, so that the gas was burnt under pressure, and so a much higher temperature was obtained than would otherwise be reached. In the glow lamp, as they were not dealing with gas, it did not seem that the materials could play any such part. There appeared to be something in this idea, because it was necessary for the mantle to have a certain composition—in fact, it was the addition of 0·4 per cent. of ceria which converted the Welsbach mantle from a ghastly failure commercially into a wonderful success. He should like to know whether the mantle was not at a much higher temperature than the flame which surrounded it, and whether a particular combination of materials did not reach a much higher temperature than another combination immersed in the same flame. If so, it was not merely the temperature of the flame which produced the result. He should like to know the reason of the difference in the colour of the light of the Welsbach and the Nernst lamps—was it a difference in material or in temperature?

Professor Ayrton was followed by Mr. Hiram S. Maxim, who said he had always understood that the light in the Welsbach burner did not depend entirely on the temperature. There were many things in Nature which gave light without any heat at all; such were glow-worms and fire-flies. His opinion was that any substances, if there were any, which did not volatilize at all, would give a light proportionate to the temperature—that platinum, or iridium, or iron, if the iron were not burnt, would all give the same light at the same temperature, provided none of the material was wasted; but if the least particle passed into the air, the flame would be coloured. In the Welsbach burner the light was not white; and this, he thought, indicated that some change was going on which made the apparent light higher than that due merely to the temperature. If carbon were heated to the same temperature, it would not give the same light.

Mr. W. M. Mordey thanked Mr. Swinburne for speaking the truth about the 200-volt lamps. The supply of lamps was, he said, a matter which really required attention, because it led to a great deal of dissatisfaction. He thought the correct plan would be for the companies to supply not electricity, but light; and instead of persuading customers to buy lamps of any particular kind, they should make an inclusive charge, and supply them with lamps themselves. This would prevent dissatisfaction. He congratulated the Society on the paper, which, he thought, would mark a new epoch in electric lighting; and they must also congratulate Professor Nernst on his invention, and take care he was not robbed of it. He agreed with Mr. Swinburne that the possibilities of the carbon filament were about exhausted; and it was remarkable that just when the filament was failing to meet the requirements, this new invention should be brought forward which seemed to meet the case. But, though the new lamp was evidently a very robust child, it was still a child, and it would at any rate take a little time to displace existing lamps.

A question was put by Dr. Fleming as to whether or not there was any deterioration in the quality of the lamps after a time, such as occurred with carbon filaments and Welsbach mantles; because this would, he said, be very important in considering the commercial value of the invention. If the lamp only required 1 or 1½ watts at starting, and, after a few hours' work, 4 or 5 watts, it would be a serious disqualification. It was well known that most of these radiants deteriorated after a time.

Mr. H. Colefax remarked that several applications for patents had already been made which appeared to claim the benefit of this discovery; but he did not think they would prove successful. With regard to the question of deterioration, he was told by Professor Nernst that, as far as he could discover, the lamps did not deteriorate in use. Of course, this could only be proved by experience; but if it were so, it would be very remarkable, seeing that in every other form of incandescent lighting yet tried there was this deterioration. He expressed a desire to learn from Mr. Swinburne what it was that limited the life of the filament; because, when he saw Professor Nernst, he did not think any explanation had then been arrived at. He was astonished at the progress which had been made in the eight months since he first saw the invention. The limit then was 200 hours; early experiments having only attained 40 hours.

The next speaker was Mr. Campbell Swinton, who said Professor Ayrton was not strictly accurate in stating that this was the first attempt to use a heated electrolyte. Some twenty years ago, Jablochkoff showed in London a lamp consisting of a strip of kaolin, along the top of which he put what he called a match, which consisted, he believed, of carbon mixed with treacle. This conducted the electricity—100 volts—until it heated the kaolin; and this formed the conductor. He would not go into the question of how far that was an anticipation of the present invention; he only wished to correct the impression that nothing of the kind had been tried. They must all admire the great advance which had now been made. With regard to the lighting power of incandescent gas-mantles, he had made many experiments on them with cathode rays, by which they could be heated to a high temperature without the use of gas in the ordinary sense; and he found there was no appreciable difference in the amount of light from a mantle of pure thoria, and one with the addition of a small percentage of ceria.

A question was asked by Mr. A. H. Dykes as to the power required for these lamps. He said he had been working out a scheme for street lighting, and had found the difficulty was that, while arc lamps were too large, ordinary incandescent lamps were not a great success. The Nernst lamp appeared to have many advantages for such purposes; and as the volume of light-giving material was so much larger than a carbon filament, it would have much greater penetrative power in foggy weather. With regard to lighting up, a man could go round and apply heat underneath the lamps quite as well as he could turn on the ordinary gas-tap.

Replying to the discussion, Mr. Swinburne said that the question of the temperature of a Welsbach burner was a very large subject, with which he could not attempt to deal fully. If they examined a burner with the mantle off, there was a zone of very high temperature which would easily fuse platinum; but most measurements made were erroneous, because they were taken with a thermopile, which never showed the real temperature of the burner. The great difficulty was to get what was in the burner up to the temperature of the burner. In dealing with the light given by incandescent bodies, it must be remembered that the light depended on the emissivity. To get the highest efficiency, one must have emissivity enough to give plenty of light without robbing the flame of its heat too soon. From a white oxide like thoria, one did not get much light; but if a small percentage of ceria or some other coloured oxide—it did not much matter what—were added, light was obtained. In making Welsbach mantles—though, having advised the Company, he must not tell everything he knew—they were sometimes raised to such a high temperature that they softened, and then they gave more light. Professor Ayrton had quoted several anonymous authorities, but had not given the reasons for their opinions; and so it was impossible to deal with them. They involved questions of thermo-dynamics, into which there was no time to go. The case of spongy platinum was altogether different. There a chemical combination was started by the heat, which would not otherwise take place. Here there was no reason to suppose there was such a combination. Spongy black would give no light; and a solution of platinum put upon a mantle would destroy its light-giving power. He believed that colour was largely a question of temperature; but one could produce different colours by using different materials. He believed the Nernst lamps would not work in a vacuum. The reason generally given was that electrolysis was going on, and that oxygen was being absorbed from the air at one terminal, and being given off at the other. This was Professor Nernst's explanation; but he thought there was another factor to be taken into account. It was perfectly simple on paper to electrolyze salt, and get out chlorine and sodium; but when one tried it he did not get either. The reason appeared to be that the chlorine and the metal were dissolved to some extent in the fused bodies, and got across very quickly. He did not think true electrolysis took place to any extent. He did not know anything about glow-worms, and doubted whether any one else did; but he did not think such questions had much to do with the matter. It was more a question of the red-hot poker order—quite simple. With regard to deterioration and its cause, after running some time the material appeared to get crystalized. What else happened he did not know. Probably there was a gradual tendency for the rod to become uneven; then it would get more heated in one part, and softer, until at last it melted. Professor Ayrton seemed to think that the compound in the Welsbach mantle was chosen entirely for giving light. But anyone who used these lights knew that the strength of the mantle was of great importance. One could get a very good light from yttria, but could not make a strong mantle that would not warp. The manufacturer had to consider strength, portability, and durability; and one point about this was that both the Welsbach mantle and the Nernst light were at a very high temperature, just short of the fusing-point, at which the material very slowly evaporated. With reference to the early Jablochkoff lamp, he had no information. His own impression was that the Jablochkoff "candle" was the only thing which was at all successful; and this was in use in 1878. The cathode rays experiments referred to by Mr. Swinton bore out what he had said about the earths—that it was simply a question of temperature. There was another inventor, he believed, working on a lamp with cathode rays; and no doubt they could be made to give an efficiency equal to the Nernst light, if the earths were raised to a sufficiently high temperature. With regard to the amount of heat given off, it depended on the quantity of power used. If they took 100 watts, probably nearly 100 would go off in heat, as only a small percentage of the energy was converted into light.

The Chairman (Mr. A. Siemens), in proposing a vote of thanks to Mr. Swinburne, reminded the audience that, with all their enthusiasm, the commercial success of the new lamp depended on the price at which it was offered; and as to this they had, as yet, no information. When electric accumulators were first discovered, it was supposed they would revolutionize the industry, and do all sorts of wonders; but though they had been certainly

useful, they had not done what was expected of them. In the case of these lamps, if they were sold at 1s. 1d., all charges included, and an ordinary carbon lamp was sold at 1s., he feared the latter would be generally purchased.

THE NEW WATER-WORKS FOR DULUTH (MINN.).

The city of Duluth (Minn.) is situated at the western end of Lake Superior, extending along the shore of the lake for about 25½ miles, with an average width of 2·7 miles, and an area of about 67½ square miles. The ground rises from the lake until it reaches a height of about 800 feet—a fact which adds to the difficulties attending the provision of a system of water supply. Up to within a short time ago, the city had been supplied by the Duluth Gas and Water Company, who took the water from the lake near the centre of the city, and had a reservoir and a distribution system. In course of time the water in the lake around the intake became polluted by sewage, and a series of typhoid fever epidemics resulted; the most serious being some three years since. About seven years ago, a municipal system was designed by the City Engineer (Mr. E. H. Keating), in which the intake was to be located about 6½ miles from the City Hall. The city was divided into three sections—a low-level, a middle-level, and a high-level district. Other plans were finally completed about two years ago by Mr. W. B. Patten, who was then the City Engineer; and they were approved, with some slight changes, by Mr. L. W. Rundlett, the City Engineer of St. Paul, who was employed as Consulting Engineer. In these plans, the general arrangement of three levels was preserved, but the contours separating them were somewhat changed. The following particulars in regard to the works were compiled by the "Engineering Record" from an interesting account contributed by Mr. T. F. M'Gilvray, the City Engineer, to the eleventh annual report of the Duluth Board of Public Works.

The low-service district comprises all that part of the city which is below a height of 290 feet, and contains the business section and about 90 per cent. of the population. The middle-service district includes all that portion above 290 feet and below 565 feet, and is thinly populated. The high-service district includes the portion above 565 feet, and at present consists of two suburbs—Woodland Park and Duluth Heights—about four miles apart. The general plan of the system consists of an intake and pumping-station about eight miles east of the centre of the city, and a 42-inch force main to a reservoir supplying the low-level section. From this reservoir water will be pumped to one supplying the middle-level section; and as the population increases and demands it, pumps will have to be installed to supply the high-level section. After many attempts and lawsuits on both sides, an agreement was finally come to in January last year, by which the city purchased the plant of the Company for $1,250,000; but previous to this time the city had begun the construction of the works hereafter described.

The intake-pipe is 60 inches in diameter, of riveted steel, and extends into the lake 1560 feet from the intake well at the pumping-station. It is ⅜ inch thick, coated with asphalte, and was delivered at the bank of the lake in lengths of 116 feet, each length weighing about 16 tons. The end-piece is bell-shaped, turned up vertically 10 feet, and draws water from a point about 55 feet below the surface of the lake. This pipe cost $11·91 (£2 9s. 8d.) per linear foot delivered on the ground. The excavation consisted of 300 feet of tunnel and 500 feet of open trench in rock, ending in 35 feet of water. The rest of the pipe was laid on the bottom of the lake, which was smooth rock for 560 feet and sand and gravel for the last 200 feet. To overcome angles in the grade, four flexible joints were used and proved to be perfectly water-tight. The cost of each of these joints complete was $398·25 (about £83).

In laying the pipe, a wooden bulkhead was built in the outer end of a section and calked tight with oakum and white lead. The pipe was made fast to the side of a raft, towed into place, and lowered to the bottom, resting upon wooden blocks attached to it. The sleeve joints were put in place, and the hook bolts screwed up tight. The water in the intake well was then pumped down, and the gate in the well was opened. Any increase in height of the water in the well could come only from leakage in the section just laid. If there was any leakage, the hook bolts were tightened until it stopped. After the pipe was laid, the tunnel and trench were filled with sand, and the trench covered with riprap. Where the pipe rests on the bed of the lake, riprap was laid along its sides to a height of about 2 feet. It was originally intended to cover this portion with sand; but, owing to a strong undertow and the heavy wave action, this was abandoned, and five anchor cribs were used to hold it in place. These were made of green white-pine timber in three compartments, and so arranged as to go entire over the pipe. The side compartments were filled with large rocks; and blocks weighing a ton each were used for filling the top. The spaces between the pipe and the corners of the crib were filled with portland cement concrete rammed in soft, making, when set, a rigid joint between the pipe and the crib. Large-size riprap with a slope of two to one was placed on all sides of the cribs. Over the intake a special crib with a grillage screen was placed.

The intake well and 200 feet of the tunnel were built by the city; but the rest of the work, including the excavation, laying, covering, and securing the pipe and joints, and supplying and placing the cribs and riprap, was done by contract at a cost of about $37,000 (£7400). The intake well was built in solid rock close to the bank of the lake. It is 20 feet in diameter and 20 feet deep below the level of the lake. The walls are 24 inches thick, of hard-burned sewer brick laid in portland cement mortar made of two parts of cement and one part of sand. Outside the walls is a backing of 6 inches of native cement concrete. In the well are two sets of copper screens of ¾-inch mesh, placed just in front of the gate-valve. The total cost of the well and screens was $9408 (£1882).

The main building of the pumping-station is 94½ feet by 56 feet, with a tower on one corner having a radius of 12½ feet, and a machine-shop 29⅓ feet by 31 feet, all two storeys in height. The foundation is rubble masonry in native cement mortar resting on solid rock, above which are six courses of cut sandstone laid with alternate headers and stretchers. Above this the walls are built of brick, 24 inches thick. Portland cement mortar was used in laying the sandstone and brickwork. A track, supported by nine steel columns built into the walls, carries a 20-ton travelling crane for use in setting up and repairing the engines. The basement floor is of portland cement concrete, with a top layer of one part cement and one part sand, trowelled to a dry finish. There are four engine-beds rising from the basement to the level of the first storey floor, and built of sandstone laid in portland cement. The building is designed for four pumps, two of 5 and two of 10 million gallons capacity, and an engine and dynamo for electric lighting. The boiler annexe is 70 feet by 46 feet, and 24 feet high, and is built of brick. It is to accommodate two batteries of three boilers each. One of these is now in place, and has a capacity for furnishing steam sufficient to pump 14 million gallons of water in 24 hours. Adjoining one side of the boiler-house is to be a building for storing coal. The roofs of the pumping-station and boiler-house are of slate supported by steel trusses. The total cost of the station, including the boiler-house and crane was $32,000 (£6400). The chimney-stack is of riveted steel lined with fire-brick, and is 150 feet high, with a minimum diameter of 6 feet. At the bottom the steel plates are ⅜ inch, and the brick lining is 18 inches thick, decreasing to the top, where the plates are 3-16th inch and the lining is 3 inches thick. The shell was delivered in sections 3 feet long, which were hoisted into place and then riveted together. The total cost of the chimney, including two coatings of turpentine asphalte paint, was $3600 (£720).

From the pumping-station the water is forced to the low-level reservoir through six miles of 42-inch riveted lap-jointed steel pipe. This pipe is designed for a capacity of 30 million gallons in 24 hours. It varies in thickness from ¼ to ½ inch, and weighs from 138 lbs. to 265 lbs. per linear foot. It was coated with asphalte in the shops, and was delivered in lengths of 28 feet. The round joints are single, and the longitudinal ones double riveted. Two or three sections, according to their weight, were riveted together on the surface of the ground, and then lowered into the trench; three derricks usually being required for this. The pipe was made tapering at one end, so as to slip easily into place in the adjoining length. The end next to the piece last laid was first lowered until the top rivet-holes came opposite each other, and was then held temporarily in place by means of a pin. The pipe was next lowered until the other holes came into the proper place and were secured by pins. The two sections were finally riveted together. Where the trench was in soft ground, sticks of pine timber 6 inches square and 3½ feet long were sunk 8 feet apart, and the pipe placed on them. Before any back-filling was done, the pipe was tested to 50 per cent. more than the working pressure; and all leaks were caulked under half of this pressure. The back-filling was carefully returned to the trench, and tamped or slushed to a height of 3 feet above the top of the pipe.

Four check-valves are placed along the line of the pipe, and also six gate-valves built to resist temperature strains. At the low points, 8-inch blow-offs were put in, and air-valve openings were placed at the high points. As the main follows the lines of streets and avenues, a number of right-angle turns were necessary, and, with one exception, these were run with a radius of 73 feet. At the cross-streets, 10-inch openings were put in for connecting future distribution-pipes. Through Lakeside, a residential portion of Duluth, a 10-inch cast-iron pipe was laid in the same trench with the trunk main, and connected to it every 800 feet by means of a T-piece and a gate. This pipe is ⅜ inch thick; and it was subjected to the same test as the main.

Near the reservoir, two chambers were built, one of 26 and the other of 20 feet radius, to accommodate the gates for the inlet, outlet, and overflow pipes of the reservoir. The walls of these chambers are 12 and 16 inches thick, are of sewer brick in native cement on a concrete foundation, and are coated on the outside with a 1-inch layer of mortar made of portland cement and sand in equal parts. The asphalte-coated overflow-pipe is a 30-inch cast-iron one ⅞ inch thick, and runs from the reservoir to a creek, a distance of 1116 feet. It was laid on strips of 6-inch square blocking 2 feet long. Near the reservoir, 600 feet of 20-inch cast-iron pipe ⅞ inch thick was laid in the same trench with the trunk main, for future connection with the middle-level service. This was laid on 6-inch square pine blocking 2 feet long, placed 6 feet apart. The cost of the 42-inch pipe laid, including manholes, branch-valves, and air and blow-off openings, was $64 (£13 6s. 9d.) per ton. The trench digging in earth and rock to an average

depth of 8½ feet, refilling, repairs to streets, gutters, culverts, and sidewalks, constructing manholes, valve chambers, and foundations, cost an average price of 8s. 2d. per linear foot.

From the low-level reservoir to the distribution-pipes a 36-inch cast-iron pipe, capable of carrying 25 million gallons of water per 24 hours, will be used, and most of it has been laid. It is ⅞ inch and 1 inch thick, and weighs 344 lbs. and 395 lbs. per linear foot, including the hub and spigot. The joints are quite deep; 100 lbs. of lead being used in each. Three lengths were jointed together on the bank, and then these 36-feet sections were lowered into the trench by means of two derricks. Pine blocks 6 inches square and 3½ feet long were placed in the bottom of the trench 6 feet apart, and the pipe laid on them. There are four gate-valves built to resist temperature strains. All right-angle curves were made with a radius of 56 feet. There are six 4-inch air-valves, placed at the high points. At the low points, 8-inch blow-offs were put in, and 10-inch openings were placed at the street intersections for the distribution-pipes. The cost of the 36-inch pipe, including the manhole, branch, and air openings, asphalte coated inside and out, was 18s. 7d. per linear foot delivered on the ground. The average depth of the trench was 7½ feet; and laying, digging, and back-filling, including repairs, cost 9s. 6d. per linear foot.

The 42-inch main with 10-inch rider crosses a stream on a steel truss of three short spans. To protect the main from frost, a double box was built round it of 2-inch by 4-inch stuff, with 1-inch white pine covering. Between the inner box and the main is an air space of 15 inches. The outer box was built about 18 inches from the inner one, and the space between them was filled with dry sawdust. This outer box was entirely covered with corrugated iron, having three coats of mineral paint to protect it from the weather and forest fires. This main also crosses ravines at two different street intersections, on wooden trestles of 12-inch square white pine. Similar frost-boxes were used here and were painted; but no sheathing of iron was used, as they will be filled in and covered when the streets are graded. The 30-inch supply main crosses a creek on a riveted steel truss 168 feet long. Similar frost-boxes were built, but sawdust was used only for a layer of 1 foot on the bottom. This was due to the fact that no dry sawdust could be obtained, and the packing, if made of the wet material, would weigh more than the combined weight of the pipe and water. In its place building-paper was used, so arranged that there were three air spaces around the pipe. The box was covered with corrugated iron, and painted like the others. This pipe also crosses a ravine on a 60-feet truss with frost-box like that on the 42-inch pipe.

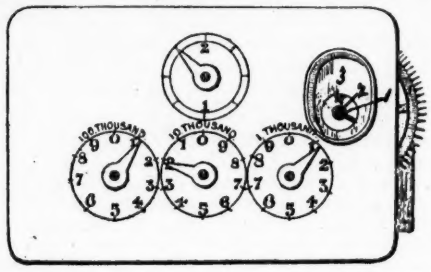
The low-level reservoir is under construction. It is to consist of two basins, with a total capacity of 30 million gallons. A temporary connection has been made between the new mains of the city and the mains of the old system, by which the reservoir of the latter can be filled, and thus supply a portion of the city. The new reservoir will be about 4 feet higher than the old one, and so will be able to fill it by gravitation. The plans for the middle and high-level districts have not yet been prepared. In a general way, each will be supplied by pumping from the reservoir of the district below it.

A Fallacy in Steam Boiler Design.—An illustration of the fallaciousness of some cherished beliefs of steam-engineers formed the text of an article in a recent number of the "Engineer." It is remarked that the latest steam-boiler designs altogether ignore the time-honoured notion that circulation of the water in a steam-generator is necessary or desirable. This statement applies specially to land boilers of the Lancashire type. It is the fact that the introduction of cross tubes in Lancashire and Cornish boilers has lately fallen into discredit. Nowadays Lancashire boilers are made with furnace tubes which nearly fill the shell, leaving only about 3 inches between the two tubes, and no more between the shell and the tubes. The gain is in the considerable augmentation of grate and heating surface. Circulation of the water used to be advocated on account of its imagined efficacy in keeping the surfaces free from deposit, and also because it was supposed to prevent priming. The former is an exploded idea; it being recognized that the most rapid circulation is powerless to prevent deposit. Unfortunately, it is not known why deposit should cling to iron as it does. The fallacy of circulating the water (say) in a Lancashire boiler, becomes evident when it is remembered that one pint of water is just as good as another, so that there is no gain in driving off 1 cubic foot of water from a furnace tube, to replace it with the same quantity of water from another part of the boiler. The one thing needful is that heating surface shall always have water in contact with it, and that there shall be a free escape of steam from the water surface, which should therefore be as large as possible. In the Lancashire boiler, no steam is made below the level of the horizontal diameter of the furnace tubes, while above this all is clear for the escape of the steam. The water below is largely superfluous, though it answers a useful purpose in equalizing the supply of steam; but there does not appear to be any particular necessity for changing it. This always supposes, of course, that the flues are carried round and underneath the boiler in the usual way, which keeps the metal equably heated. In Scotch boilers, where the heat does not pass under the bottom of the shell at all, means must be taken (as by pumping the water out of the bottom and returning it to the top) to equalize the heat when the fires are first lighted.

REGISTER OF PATENTS.

Gas-Meter Index.—Stratford, J., of Lower White Cross Street, E.C. No. 1045; Jan. 14, 1898.

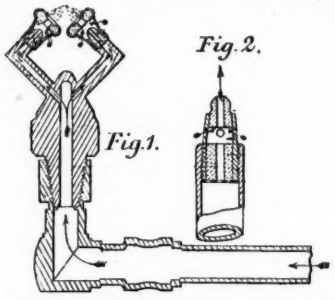
The patentee proposes to render all parts of a gas-meter index accessible for examination as to correctness of mechanism and workmanship, by providing a pinion (1), as shown in the engraving, on a leading wheel of



the gas-meter index, made to run in a bearing (2) in the front index-frame, so that the wheel can be removed for testing purposes, and replaced. The ringed opening (3) in the dial-plate of the index corresponds to the screw step or other bearing (4) suitable for the reception of an official stamp in order to secure the same after testing.

Acetylene Burner.—Legge, J. St. C., and Cooper, A. S., of Dublin. No. 1054; Jan. 14, 1898.

In fig. 1, the burner is of the duplex type, having its two combustion outlets arranged so that the flames impinge one against the other as shown. Just beneath each of the top plates is a mixing-chamber, having side apertures therein, through which air is drawn by the pressure of the acetylene gas issuing through the jet-aperture in the steatite block fixed



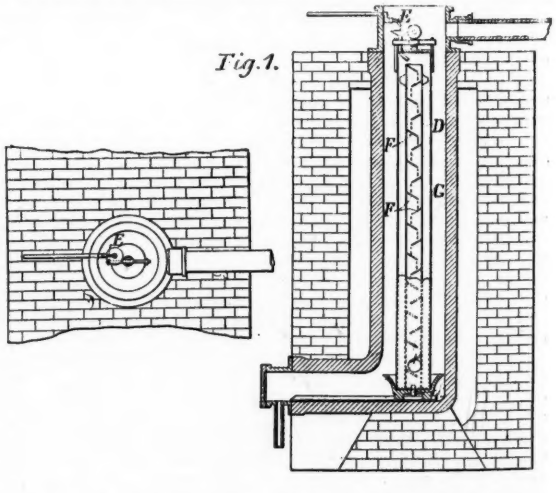
in the upper end of the branch-pipes. The chambers are so secured to the branch-pipes that they can be renewed when worn. The holes in the sides of the mixing-chamber are preferably made about ⅛ inch from the top plate of the burner. They are usually four in number, and are one size smaller than the combustion outlets.

In fig. 2, the mixing-chamber is, as before, provided with side apertures, and is situated just below the combustion outlet, and between it and the jet-aperture in the central block.

Manufacture of Gas from Oil.—Chandler, S. & J., of Kennington Oval, S.E. No. 1251; Jan. 17, 1898.

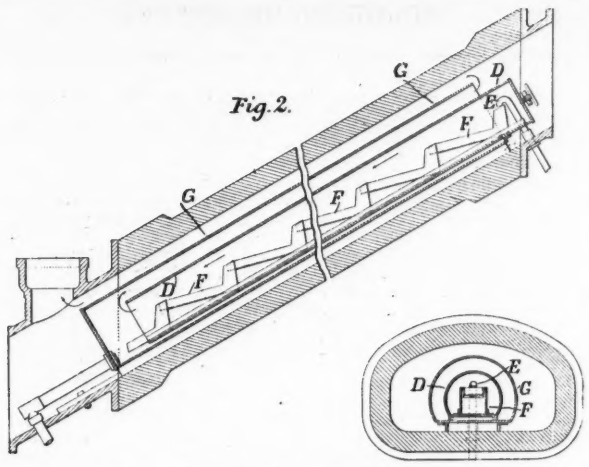
The patentees claim, in this invention, the combination with an ordid nary gas-retort of a decomposing-chamber adapted to be inserted in the retort, and to be supported therein out of contact with it; the chamber being provided with inclined trays or baffles, down which the oil to be vaporized passes by gravitation, and being closed at one end in such a manner as to ensure that the gas issuing from it shall, in escaping from the retort, have to pass in contact with the heated walls of the latter.

Fig. 1 shows a plan and vertical section of an upright retort having a



decomposing-chamber constructed according to this invention. Fig. 2 is a longitudinal and cross section, showing its application to an incline-retort.

Fig. 2.



D is the decomposing-chamber, in the form of a tube adapted to be inserted in the retort, and into which the oil to be vaporized is admitted through a pipe E. F are the trays down which the oil passes by gravitation; and G is an outer tube surrounding the decomposing-chamber. In fig. 1, the trays are in the form of a series of baffles placed on opposite sides of the decomposing-chamber, which is open at the top, while the enclosing pipe or tube is closed at the top by a removable cover, and at the bottom is open to the interior of the retort.

When in operation (the retort being properly heated and the mouth closed), oil is allowed to enter through the pipe E and pass into the decomposing-chamber, whence it gravitates down the baffles F in a zigzag course, and is converted into gas. The supply of oil should be so regulated that no free oil reaches the bottom of the decomposing-chamber; but if oil should accumulate at the bottom, there are pipes for drawing it off. The gas produced passes upwards out of the decomposing-chamber into the tube G, and is thence compelled to traverse downwards between the outer wall of the chamber and the inner wall of the tube to the opening, at foot, whence it again passes upwards, in contact with the wall of the retort, to the outlet-pipe.

In fig. 2, the trays F are arranged on the inclined chamber, in such a manner that the lip of one tray rests upon the rear end of the next one; the surfaces of the trays being of only slight inclination, so that the oil will gravitate slowly along them. In this arrangement also, the decomposing-chamber D is closed at the top, while the enclosing pipe G is closed at the bottom, and has connected to it the pipe K for the escape of surplus oil. The gas produced passes down the chamber D, then upwards through the space between the chamber and the enclosing tube G, and thence down between the tube and the heated walls of the retort to the discharge aperature.

When applied to a horizontal retort, the patentees would use asingle shallow tray F extending the whole length of the retort, and occupying as nearly as possible a central position therein; the tray being placed at such an angle as to give the requisite fall for the oil.

Gas-Compressing Apparatus.—Greyson de Schodt, P., of Brussels. No. 1893; Jan. 24, 1898.

This invention has reference to apparatus for supplying gas to burners at a somewhat greater than the main pressure, for the purposes set forth in patents No. 8509 of 1896 and No. 1252 of 1897. The gas is drawn into a compression cylinder, and expelled from it at the requisite pressure by a piston which receives its motion from a motor cylinder whose piston is connected with the piston of the compression cylinder. The piston of the motor cylinder is actuated by motive fluid—preferably water—contained in a chamber or reservoir to which the fluid is supplied under pressure. The entrance and exit of the motive fluid to and from the motor cylinder is controlled by a distributing-valve, the position of which is regulated by an auxiliary piston located in the reservoir; the piston being in turn controlled by a valve actuated by some moving part of the apparatus at the termination of each stroke of the motor piston. The valves and valve mechanism are located within the reservoir in a position below the water-level.

Incandescent Gas-Mantle.—Crocker, S. H., of Furnival Street, E.C. No. 2015; Jan. 25, 1898.

In preparing a solution from which to produce a mantle in accordance with this invention, the patentee dissolves in water a salt of thorium (preferably the nitrate), and adds thereto an amount of nitrate of cerium; the important feature of the invention being the proportions in which the two substances are mixed together. To make up the solution, there is added to the nitrate of thorium in solution an amount of nitrate of cerium exceeding 2 per cent., and not exceeding 12 per cent.; and this addition of cerium is said to "considerably strengthen and increase the durability of the mantle, at the same time that it enables it to emit a strong light."

Producing Acetylene.—Thorp, T., of Whitefield. No. 2454; Jan. 31, 1898.

This is a modification of patent No. 19,823 of 1897, and the improvements have reference: First, to means for more perfectly regulating the admission of carbide from the lower hopper into the generator, and for facilitating access to the admission-valve without first emptying the gas-holder and generator of gas; and, secondly, to the construction and arrangement of the filtering apparatus or washer.

Abstracting Impurities from Coal Gas.—Kirkham, H., of Queen Victoria Street, E.C. No. 5407; March 5, 1898.

This invention relates to the filling of scrubber-washers so as to split up the water into "films" of greater total area, and bring it more thoroughly into contact with the gas than by the surfaces now in use. To effect this, a number of rolls of thin metal are so curled that spaces are left for the passage of the gas, when they are placed in, so as to fill cages or baskets such as were described in patent No. 10,822 of 1896—a number of the cages or baskets containing the rolls being arranged in the drums or wheels of the scrubber-washer, forming washing surfaces.

Fig. 1.

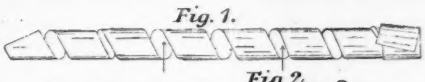
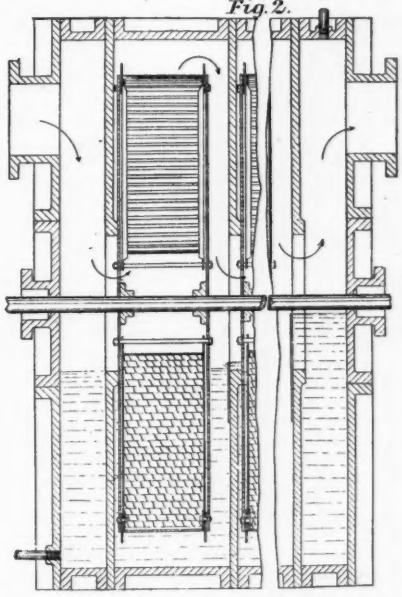


Fig. 2.

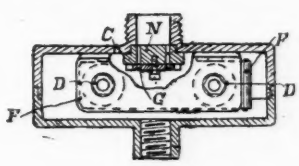


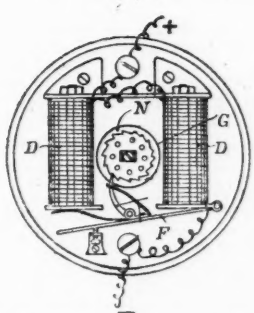
The roll (shown in fig. 1) consists of a thin strip of iron or steel, curled so as to leave a space or slit between adjacent convolutions, and provided with a head for the purpose of stiffening the curl—formed by simply winding the strip spirally (upon itself) for slightly more than one complete turn.

Fig. 2 is a vertical section of part of a scrubber-washer having washing surfaces formed of rolls, whose length is almost as great as the internal width of the cages or baskets in which they are arranged parallel to the shaft of the drum or wheel. The gas, in passing radially outwards in the baskets, as indicated by arrows, besides striking the external wetted surfaces of the rolls, and consequently passing along them, will travel through the spaces or slits of the rolls and strike against the opposite internal surfaces thereof, as indicated by arrows in fig. 1, with the result of causing the gas to pass along within the rolls in contact with the internal wetted surfaces.

Igniting and Extinguishing Gas-Flames.—Imray, O.; a communication from the Industriewerke Kaiserslautern Metall-und Porzellan Fabrikation, Gesellschaft mit beschränkter Haftung, of Kaiserslautern, Bavaria. No. 6625; March 18, 1898.

This appliance, for admitting and cutting off the gas supply to burners from a distance, is shown in vertical section and plan with the top cover removed.





Upon the gas-pipe is fixed a hermetically closed casing, which is always filled with gas, that can flow through an opening C into a small tube leading to an igniting gas-jet. If the ignition is to be effected by an electric current, an electro-magnet D is placed in front of an armature F pivoted at one end. The armature is held away from the electro-magnet by a spring, when no current is passing. The closing of the gas supply to the burner is effected by a toothed wheel G, having small holes arranged in a circle concentric with the wheel, the number of which holes is half that of the teeth of the wheel. The latter rotates upon a pin

screwed to a piece N arranged below the burner, and having small channels formed through it. The armature has pivoted to it a pawl, which is kept by a spring in gear with the wheel G. At each closing of the electric circuit, the armature, in being attracted, effects the partial rotation of the wheel through a distance equal to one tooth, in such manner that by the one such motion the holes of the wheel are brought over the holes of the piece N, so that gas can then pass to the burner, while on the next motion of the wheel the holes are closed by the body of the wheel, whose holes are then in an intermediate position; and consequently the gas supply is cut off.

Producing Acetylene.—Smith, F. H., of Newcastle-on-Tyne. No. 5941; March 10, 1898.

According to this invention, calcium carbide is sealed in water-tight packages in which there are small holes. When one of the packages is placed in water, or one of the holes put in communication with it, the water gradually and slowly enters, and causes the gas to be steadily produced. In order to distribute the water evenly among the carbide, internal wicks are provided leading from the holes. The packages are made of sufficiently strong and durable material to retain in them the lime resulting from the decomposition of the carbide.

Preventing the Deposit of Solid Carbon when Burning Acetylene.—Gurovitz, E., of Vienna. No. 7184; March 24, 1898.

This "method of producing acetylene gas that will burn without deposit of solid carbon," consists in mixing with the acetylene small quantities (from 0·4 to 1 per cent.) of an oxidizing gas. The patentee remarks that, having regard to high combustion heat of acetylene and the heating of the burner effected thereby, gases may be employed as possessing an oxidizing action according to this invention, which only exercise such oxidizing action at high temperatures—such as carbon dioxide. Also atmospheric air may be employed without risk, as the quantity of the medium to be mixed with the acetylene is only very small, and consequently quite insufficient for producing an explosion.

For practically carrying out the process, the gas having oxidizing action can be mixed with the acetylene either at the burner, in order there to be brought to the requisite temperature for having the desired effect, or the gas can be introduced into the apparatus for generating the acetylene, in order to be there mixed with it before passing to the burner.

Producing Acetylene.—Daix, V., of Paris. No. 7521; March 29, 1898

This apparatus for the automatic production of acetylene gas comprises (1) a gasholder and an automatic distributor of feed water; (2) a gas-generator arranged air-tight on the bottom of the water-tank of the holder, and formed of an external envelope hermetically closed by a door, arranged on the outside of the water-tank; (3) a drawer placed in the external envelope, and divided into several compartments by transverse vertical partitions; (4) carbide baskets of perforated sheet iron placed in the compartments of the drawer, to be successively used; and (5) means for leading water from the holder to the generator, conducting the gas from the generator into the holder, and preventing its return to the generator.

APPLICATIONS FOR LETTERS PATENT.

2631.—Junge, C., "Globe for incandescent lamps." A communication from I. Kahn and Co. Feb. 6.
2657.—Thompson, W. P., "Manufacture of calcium carbide." Feb. 6.
2681.—Burchard, L. S., "Coin-controlled gas-meters." A communication from W. Webber. Feb. 6.
2683.—Simms, F. R., "Explosion engines." Feb. 6.
2692.—Crowden, C. T., "Internal combustion engines." Feb. 6.
2699.—Barratt, F. W., "Acetylene lamps." Feb. 7.
2771.—Türr, R., "Incandescence bodies for illuminating purposes." Feb. 7.
2818.—Ross, J. H., "Acetylene generators." Feb. 8.
2832.—Chandler, S., jun., & J., "Washing or scrubbing gas." Feb. 8.
2847.—Nunn, F. C., and White, T. H., "Gas or oil engines." Feb. 8.
2856.—Kitto, W. H., "Igniting devices for internal combustion engines." Feb. 8.
2873.—Poppel, A. H., "Manufacture of air gas." Feb. 8.
2888.—Entwisle, W., "Incandescent gas-burners." Feb. 9
2935.—Kellett, J. T., "Internal combustion engines." Feb. 9.
3000.—Lauckner, O., "Regulators for gas-burners." A communication from M. Lauckner. Feb. 10.
3023.—Hawkins, H., "Acetylene gas-generators." Feb. 10.
3026.—Koppers, H., "Coke-oven with apparatus for utilizing the hot waste gases." Feb. 10.
3043.—Hervieu, G., "Generating acetylene." Feb. 10.
3101.—Brewer, T. R., "Generation of acetylene gas." Feb. 11.
3102.—Watts, C. J., "Generator for acetylene gas." Feb. 11.
3105.—Allirol, H., Wilson, G., and W. & B. Cowan, Ltd., "Igniting devices for incandescent gas-burners." Feb. 11.
3108.—Bosch, R., "Gas-engines." Feb. 11.
3115.—Back, A. C. L., and Evans, W., "Explosion engines." Feb. 11.

Rates and the Gas Finances at Walsall.—In a report presented to the Walsall Town Council yesterday week, the Finance Committee mentioned that they had been informed that, in the next rate estimate it would not be safe to include more than £3500, in respect of gas-works profit. Commenting upon this, Mr. Brownhill pointed out that the Gas Committee were £5000 out of pocket each year in consequence of having reduced the price of gas 2d. per 1000 cubic feet and allowed a discount of 5 per cent. In addition, £697 more had this year been paid for coal, a further £900 in interest and repayment of capital outlay, and £650 more in rates. The consumption was also affected by the year being the warmest, finest, and driest ever known. The report was adopted. The balance-sheet of the gas undertaking for the year 1898 was submitted. It was shown thereby that the net profit for the year was £3568, against £4519 for the year 1897, or £951 less. The diminution in profit, it was stated, was due to additional payments for interest and sinking fund in respect of capital expenditure which was not yet productive of income, and to the increased cost of coal.

CORRESPONDENCE.

[*We are not responsible for the opinions expressed by correspondents.*]

Sulphate Working at Widnes.

Sir,—In looking over Mr. Carr's figures of the cost of sulphate making at Widnes, one cannot but admit that his improved superheater has effected great economy in fuel as compared with the previous working; and the reasons for such a result are quite obvious. But I must confess myself quite in the dark as to the part played by the superheater in bringing about a reduction in the amount of acid required to produce a ton of sulphate.

Sulphuric acid and ammonia combine in definite proportions to produce sulphate of ammonia; and I fail to see how a superheater can affect the combination in the slightest degree. Similarly with regard to the production of sulphate per ton of coal, how can this be affected by any method of superheating the liquor? A properly constructed sulphate plant will take out all the ammonia from the liquor, with a given quantity of acid of definite strength, without the aid of a superheater, in which case a larger amount of steam will be required in the still, which means an increased expenditure of fuel. The sole function of a superheater is to reduce this expenditure; and it would be interesting if Mr. Carr would explain how it is that the other results are affected as stated. A reduction of 25 per cent. in the acid required, combined with an increase of 10 per cent. in the sulphate made (which is practically what Mr. Carr claims), should ensure a great future for his improved superheater, if the claims can be substantiated.

It would also be interesting to know what method of raising steam is adopted at Widnes, as the cost of fuel, even with the improved arrangement, is high.

Joseph Tysoe.

East Greenwich, Feb. 18, 1899.

Sir,—In your last week's issue, Mr. Carr gives some figures as to the cost of manufacturing sulphate of ammonia; but they only confirm the old story that "figures can be made to show anything."

The ordinary reader would probably look upon the figures of Mr. Carr as the total cost in connection with the manufacture of sulphate of ammonia, excepting the actual cost of the ammoniacal liquor. But this must surely be far from the case; for, not only do the charges for wages, fuel, bags, packing, and loading, seem to be outrageously low, but other items which are usually incurred in the manufacture appear to be omitted—such as gas, water, and general charges, cost of superintendence, depreciation and repairs, cartage and carriage (if any), and the cost of purifying the spent gases.

It is interesting to compare Mr. Carr's figures of last week with those appearing in your issue for the week ending April 17, 1894, for another manufacturer's cost of making. Mr. Carr's figures are £1 17s., as against the latter's £5 7s. 1d.

Perhaps Mr. Carr would kindly amplify his costs, and make them more inclusive.

Arthur F. Ward.

Middlesbrough, Feb. 18, 1899.

The Flash-Point of Oil.

Sir,—In your issue of the 7th inst., you have kindly invited further correspondence on the flash-point of oil; and you give your correspondents two points for discussion. The first is whether there has been a deliberate betrayal of the public interest in the alteration of the method of testing kerosene for the flashing point. I think I can easily prove "the betrayal of public interest;" but as to its being "deliberate," that is a separate and harder question.

The introduction of petroleum from America caused many deaths from lamp accidents. Dr. Letheby and others got up an agitation for a standard of safety to prevent these deaths, with the result that the first Act was passed in 1862. It said: "Petroleum for the purposes of this Act shall include any product thereof that gives off inflammable vapour at a temperature of less than 100° Fahr." All lamp oil is "product." In this definition, we have quite clearly the aim of our legislation—viz., to regulate and control the trade in oil which can give off, under 100° Fahr., vapours sufficient to ignite on a light being applied, and to exclude from surveillance all that does not give off ignitable vapour at this temperature. The reason for fixing on 100° Fahr., instead of a higher or lower temperature, is given in Dr. Letheby's answer to the Home Office when consulted on the subject of a standard: "Petroleum would be perfectly safe for all practical purposes when it does not evolve inflammable vapour at a temperature below 100° Fahr.; for there is no ordinary storage place or lamp that could, according to my observation, reach such a temperature." The cause of the legislation was lamp accidents; and we see from this that it was the temperature that oil attained in lamps that fixed the standard.

We have all much knowledge at present that even the experts did not possess in 1862. How was the inflammable vapour to be tested? We now determine the point wanted by taking the flashing point of the oil. The flashing point is the lowest temperature at which a very slight explosion can be obtained. The home manufacturers always used a close test, which gives the truth. The Americans, however, at this period tested in an open vessel, which let the vapour dissipate away into the air; and they were followed by the Petroleum Association in London. This open test—which was, in fact, the one adopted by the 1868 Act—we all know now to be deceptive, and to give a point 27° higher than the truth. When an oil by this test flashed only on heating to 100°, in a large pool, in a large lamp, or in any position in which the vapours were not allowed to dissipate into the atmosphere, the same oil could give an explosion at 73°, and permanently catch fire a few degrees above it. This was not known then. So late as 1894, Colonel Majendie, in his evidence, said that, in his opinion, oil of 73° Abel flash-point in a barrel was in no danger of explosion or fire until heated to 100°; but since then he gave details of many accidents, showing that latterly he saw clearly that an oil, 73° by Abel test and 100° by the old open test, was very dangerous at ordinary summer temperatures far under 100°. When 73° oil was exposed for sale in open pails for convenience of retail, the vapours travelled out some distance to a light to get ignited; and when some was spilled in a shop with a light near, the vapours exploded, sending out a tongue of

flame to kill a child in a passage outside. All this was indefinite in 1862; and the Act defined no *method* of determining whether an oil gave off vapour at 100° or not. It also appointed no inspectors, and gave no way of enforcing its demands. The Americans continued to send in oil that gave off explosive vapours at ordinary house temperatures, and even with more confidence than before—professing to believe that their own method of testing gave the truth. This law, therefore, did no good.

Such a state of matters could not continue. In 1868, an Act was passed to appoint inspectors and define the method of testing, and so to put the law into operation. In 1867, a Committee of the House of Commons, after investigating the matter, had reported that the standard should be raised to 110°. The Government referred the defining of the test to three Chemists—Professor Abel, Professor Attfield, and Dr. Letheby—and also asked them to specify the lowest standard they thought would be safe. They adopted a deep cap half-filled, which protected the vapours from being rapidly dissipated into the atmosphere, and which, indeed, gives practically the same point as the Abel close test; and they reported that if this test were "rigidly adhered to," the standard might be left at 100°. The Government brought forward the Bill with 100° as the standard, and with the test of the three Chemists as the method. The Petroleum Association used their great influence on the Home Office to get their own open test inserted instead.

The Under-Secretary referred the matter to Professor Abel alone (though Professor Attfield and Dr. Letheby were both at hand)—instructing him, however, "to give way on no point affecting the efficiency of the test." The result was that the Act was passed with 100° as standard, which suited the test of the three Chemists, which gave the truth, but with the test of the Petroleum Association, as method, which gave a point 27° above the truth. When the Association test was adopted, the standard should have been raised to 127° or whatever was the equivalent of 100° by the test of the three Chemists. Professor Abel should have been asked to make out this equivalent or volunteered it; but anyhow he did not do it. The investigations by the three Chemists were the only ones for the Home Office on the point of standard; and any divergence from this must be looked on as error and mistake. The error was one of about 27° caused by fixing the standard with one test and putting in another at the last moment, without altering the standard to suit the new test. The Chairman of the Parliamentary Committee protested against the lowering of the flash-point from the standard recommended by the Committee. The Under-Secretary (Sir James Fergusson) answered ["Hansard," Vol. 192 (1868), 1618]: "The matter of standard had been referred to three Chemists, one from each side, and one from the War Office. The recommendations of these gentlemen had been adopted *in their entirety;* and he believed the measure as now settled would ensure perfect safety. The modifications which had been made would effect the same end as the more rigorous test originally proposed; and he had the authority of the Petroleum Association for saying that the trade would not be injuriously affected."

Sir James Fergusson would seem to have had no suspicion of the extent of the blunder he was making; and Professor Abel appears never to have defined or even acknowledged the error he made. This open test that he was responsible for was not only false, but could be manipulated to any extent. But both knew that, if an error was made, it was one that would please a great body of interested persons—the petroleum merchants. The Home Office have always been very considerate of any representation from the sellers of foreign oil, and treat their scientific experts with a childlike confidence that is very beautiful. Some of us think they would have served the people better if they had shown the same suspicion of them that they have always done of the home trade. Certainly it was the duty of the Home Office to defend us from the representations or misrepresentations of a trade that was at the command of unscrupulous foreigners, just as much as from a home trade.

In 1879, when the close Abel test was adopted, Professor Abel made out the equivalence, with the Abel cup, of 100° with the open test, instead of going back to the right point—the point with the Abel cup equivalent to 100° with the test of the three Chemists. He had a chance of correcting his old mistake, for the Government deliberately asked him "whether 100° Fahr. (or its equivalent in any modified method of testing) is, in your opinion, calculated to afford adequate protection to the public without unduly interfering with or restricting the trade? If not, what alteration in this respect should be made?" But again he fails to recognize his responsibility, fails to see that it is he who ought to make himself acquainted with all the outs-and-ins of the case, so as to protect us all from trade ignorance and errors, and particularly from the experts of the foreign millionaires; and he gives no opinion of his own, but founds his report on the general ignorance of the public. He answered: "There are not, in my judgment, well-established grounds for considering that the present flashing point of 100° Fahr. is not calculated to afford adequate protection to the public." Who in all the world was to supply the "grounds," if not he? There was nobody instructed on the subject in the country except himself and the interested parties. The result was that the law again allowed oil that gave off vapours capable of exploding at 73°, instead of restricting the trade to oil giving off vapours above 100°, as clearly demanded by the 1862 Act.

There was some excuse for Professor Abel being ignorant in 1868, on being called on to give a sudden decision; but none whatever in 1879. The science of the matter was thoroughly investigated long before that, and given effect to in different States of the Union; and Professor Abel was not so personally ignorant when he recognized his personal responsibility, for it was by his advice that oil in barracks was restricted to that above 105° Abel test. The Home Office officials blundered among themselves somehow; and so it came to pass that we never had a law except one that did definite harm. Our laws have always encouraged the production of dangerous oil, and saved manufacturers and merchants from responsibility for the inevitable results. Home manufacturers are hampered by laws made to save men from remote and rarely occurring dangers; but when it is foreigners causing a death every day, then to prevent that is rank Protection, if, while saving lives, it gives at the same time a perfectly legitimate advantage to a struggling home trade that every wise man would conserve. It is the home manufacturer who keeps oil cheap by competition; for places much nearer the refineries, but where there is no competition, have petroleum twice as dear as in Britain. If we are all to be selfish and regardless of public advantage, then no doubt it is the right thing for gas manufacturers to help the powerful Standard Oil Company to kill the home manufacture; for if it ceased to exist, the price would be doubled to the poor at once and the oil be no safer—thus encouraging the use of gas.

Your second query was, "Has there been any change in the character of kerosene in consequence of what Mr. Ure at Broxburn called 'the one fatal step taken on June 15, 1868'?" The answer is, "No; there was no increase of dangerous oil by it." The 1862 Act made dangerous oil illegal, but failed to get its clear requirements enforced. The 1868 Act made legal the importation of the dangerous oils which had caused numerous deaths, and thus perpetuated and protected the very evil that the laws were framed with the express object of preventing.

The Home Office is just a mite too timid in regard to hampering the foreigners. No good can be done without forcing them to alter their evil ways. Make them send us in oil free from naphtha, and the naphtha separate (we need it also), and give their outcries no more consideration than if they were Scotch—even though they are made through numerous experts of high-standing, receiving magnificent fees.

Broxburn, N.B., Feb. 16, 1899. D. R. Steuart.

Flash-Point Politics.

Sir,—In your issue of the 7th inst., I notice letters from Mr. D. R. Steuart and Mr. Alex. Robertson. As Secretary to the Rural Labourers' League—an association acting in the interests of the rural population—will you allow me to protest against the organized attempt now being made to tax the working and poorer classes in order that certain high-flash oil-makers may become millionaires? Your correspondents, from the statements they make, must presume that your readers have not studied the evidence given before the Petroleum Committee. Mr. Robertson, writing in the interests of the Scotch oil trade, speaks of this country as being made the "dumping ground" of low-flash oils. This statement, so frequently made, is pronounced by the report of the Committee to be absolutely unfounded. I find from the evidence that in most countries in Europe the legal flash-point is the same as or lower than here. In Germany it is 3° lower. Throughout India and Ceylon (with their hot climates), China, and other countries in the East, it is also the same as or lower than ours. So far from being the "dumping ground," the quantity of ordinary petroleum sent to this country—though vast in itself—is but a small proportion of the total quantity made.

I gather from the evidence that Mr. Steuart is described as the Head Chemist of a Scottish (the Broxburn) oil company; and that he claims to have started the discussion with reference to the flash-point. I respect his desire to protect the home industry—a desire we all share, if it can be done without inflicting injury on others. His statements in your columns will not stand being tested by the evidence given before the Committee. It is true that Mr. Steuart, when refuted by evidence of the highest rank, gets over the difficulty by concluding that he is right and all the others are wrong. He rightly includes Professor Chandler and Professor Engler among "the greatest chemists of the world." I find by the evidence, however, something which Mr. Steuart does not tell us—viz., that Professor Chandler declares that, after 25 years' experience, the 73° Abel test secures the safety of the public, and that the same accidents would happen with reckless people with oil 20° higher; also that this is the result of experience throughout the world. So much for Professor Chandler's opinion. The other great chemist quoted—Professor Engler—states that statistics collected, and experiments made, do not justify raising the flash-point in Germany or England. He adds that 18 years' trial in Germany of 70° (3° below ours) has proved it to be satisfactory; to raise it would raise the price.

It seems to me, on studying the evidence, that the Committee has been used as a means of advancing certain trade interests, and much money has been spent with the view of discrediting everything below 100°. There are no grounds for this on the score of public safety. I note that Mr. Steuart's statements about "hundreds of accidents every evening" resolved themselves under cross-examination into a matter of hearsay.

I learn from inquiries I have made in different parts of the country, that at the present time the difference in the retail price between the ordinary petroleum and the high-flash kind is about 4d. per gallon. What the difference would be if three-fourths of the present supply were prohibited, no one can tell. The difference in price will not affect the well-to-do classes, as they can afford to buy expensive oil, and can store it; but it is sure to affect the working and poorer classes, who use the ordinary petroleum, and who buy it in small daily or weekly quantities. To the agricultural labourer, with wages from 10s. to 14s. per week, every 1d. is of importance. Surely his lot is already hard enough; and to tax him to the amount of 4d. or 6d. (or no one can tell how much more) per week without sufficient cause—and evidently in the interest of certain high-flash oil makers—is a great injustice.

95, *Colmore Row, Birmingham, Feb.* 18, 1899. F. G. Pyne.

Matlock Bath Gas Supply.—The report on the gas undertaking of the Matlock Bath District Council for the past year, which came before the members last Tuesday, was a very favourable one, and increases were reported in output and consumption, as well as in income. On the 31st of December there stood a balance of more than £900 on the revenue and capital accounts. The General Manager did not anticipate that the gas undertaking would be a burden on the rates; but he asked for a deficit of £200 to be taken into account in the next rate. The Clerk reported that he had received £3777 from the Hanley Corporation on loan, to cover the costs of promoting the Matlock Bath Gas Bill. This sum would be repayable in ten years.

The Liverpool Corporation and the Supply of Water Gas.—The recently issued report of the Departmental Committee on Water Gas, given in another part of the "Journal," was last Thursday under consideration at a meeting of the Health Committee of the Liverpool Corporation. The Town Clerk (Mr. Harcourt E. Clare) said the effect of the Departmental Committee's recommendation was the carrying out of what was suggested to the Gas Company in March, 1898. Several members insisted that immediate steps should be taken to secure a remedy from the Company. A resolution was unanimously adopted that the local Members of Parliament should be asked to press the Government to bring in a Bill to carry out the recommendations of the Committee.

PARLIAMENTARY INTELLIGENCE.

HOUSE OF LORDS.

The following progress has been made with Private Bills:—

Bills presented and read the first time: Arbroath Corporation Gas Bill, Barton-on-Sea Water Bill, Bognor Urban District Water Bill, Bury Corporation Bill, Bury Corporation Water Bill, Church Stretton Water Bill, Coalville Urban District Gas Bill, Cobham Gas Bill, Dumbarton Burgh Bill, Dundee Gas, Tramways, and Extension Bill, Fylde Water Board Bill, Gainsborough Urban District Council Gas Bill, Glasgow Corporation Gas and Water Bill, Glastonbury Water Bill, Lanarkshire (Middle Ward District) Water Bill, Leigh-on-Sea Urban District Council Bill, Loughborough Corporation Bill, Mid-Kent Gas Bill, Nene Valley Water-Works Bill, Newhaven and Seaford Water Board Bill, Perth Water, Police, and Gas Bill, Rawtenstall Corporation Water Bill, Salford Corporation Bill, Skipton Urban District Gas Bill, Southampton Corporation Water Bill, Stockton and Middlesbrough Water Bill, Wakefield Corporation Bill, Whitehaven Corporation Bill, Wishaw Water Bill, Wolverhampton Corporation Bill, Workington Corporation Water Bill.

Bills presented, read the first time, and referred to the Examiners: Airdrie and Coatbridge Water Bill, Bristol Gas Bill, Cambridge University and Town Gas Bill, Great Yarmouth Water Bill, Hastings and St. Leonards Gas Bill, Herne Bay Water Bill, Lea Bridge District Gas Bill, Loughborough Gas Bill, Lowestoft Water and Gas Bill, Rushden and Higham Ferrers District Gas Bill, St. Albans Gas Bill, St. Neots Water Bill, Skipton Gas Bill, South Essex Water Bill, South Hants Water Bill, Stretford Gas Bill, Totland Water Bill, Walton-on-Thames and Weybridge Gas Bill, Yeadon and Guiseley Gas Bill.

The Examiners reported that the Standing Orders had not been complied with in the case of the Newhaven and Seaford Water Board Bill and of the Skipton Gas Bill.

On Tuesday, the Earl of Morley moved the new Standing Order, to which reference was made in the "JOURNAL" last week. It was in the following terms: "The Council of any Administrative County alleging in their petition that such Administrative County, or any part thereof, may be injuriously affected by the provisions of any Bill relating to the water supply of any town or district, whether situate within or without such county, shall be entitled to be heard against such Bill." He said that, under the present Standing Orders, County Councils could only be heard at the discretion of the Committee before whom the Bill in which they might be interested came. The object of the new Standing Order was to give them an absolute right to be heard on all matters affecting the water supply of their districts. It had been suggested by the County Councils Association, and it would bring their Lordships' Standing Orders into exact conformity with those of the House of Commons. The Marquis of Ripon said he was glad their Lordships had thought fit to give County Councils *locus standi* before Committees. It was a right which they certainly ought to enjoy. The motion was agreed to.

HOUSE OF COMMONS.

The following progress has been made with Private Bills:—

Bills presented, read the first time, and referred to the Examiners: Crowborough District Water Bill, East London Water Bill, East London Water (Temporary Supply) Bill, Gaslight and Coke Company Bill, Horsforth Water Bill, Ilford Gas Bill, Menstone Water Bill, Metropolitan Water Companies Bill, Redditch Gas Bill, Shotley Bridge and Consett District Gas Bill, Stockport District Water Bill, Walker and Wallsend Union Gas (Electric Lighting) Bill, West Gloucestershire Water Bill, West Middlesex Water Bill, Woking Water and Gas Bill.

Bills presented, read the first time, and ordered for second reading: Ayr Burgh Bill, Barking Town Improvement Bill, Belfast Water Bill, Birmingham Corporation Bill, Blackpool Improvement Bill, Bootle Corporation Bill, Bradford Tramways and Improvement Bill, Brigg Urban District Gas Bill, Burley-in-Wharfedale Urban District Water Bill, Clay Cross Water Bill, Crowborough District Gas Bill, Darwen Corporation Bill, Derby Corporation Water Bill, Dublin Corporation Bill, Fishguard Water and Gas Bill, Godalming Corporation Water Bill, Goole Urban District Council Bill, Horsforth Urban District Council Water Bill, Ilford Urban District Council Gas Bill, Leicester Corporation Water Bill, London Water (Finance) Bill, London Water (Purchase) Bill, Manchester Corporation (General Powers) Bill, New Mills Urban District Council Water Bill, Nottingham Corporation Bill, Nuneaton and Chilvers Coton Urban District Council Water Bill, Otley Urban District Council Water Bill, Rhondda Urban District Council Bill, St. David's Water and Gas Bill, Scunthorpe Urban District Gas and Water Bill, Sheffield Corporation (Derwent Valley) Water Bill, Shirebrook and District Gas Bill, Stockport Corporation Water Bill, Warrington Corporation Bill, Wetherby District Water Bill.

The Examiners reported that the Standing Orders had not been complied with in respect of the Belfast Corporation Bill, the London Water (Aqueducts and Works) Bill, and the London Water (Welsh Reservoirs and Works) Bill.

Petitions have been presented against the following Bills: Derby Corporation Bill, by the Nottingham Corporation; Leicester Corporation Water Bill, by the Nottingham Corporation; Sheffield Corporation (Derwent Valley) Water Bill, by the Nottingham Corporation.

Motions to reject the following Bills on second reading have been given by the members named: Gaslight and Coke Company Bill, by Mr. Pickersgill; London Water (Purchase) Bill and London Water (Finance) Bill, by Mr. Whitmore; East London Water (Temporary Supply) Bill, London Water (Purchase) Bill, Metropolitan Water Companies Bill, West Middlesex Water Bill, and Woking Water and Gas Bill, by Sir F. Dixon-Hartland.

On Tuesday, Mr. Harry Samuel brought in the Bill of which he had given notice "to amend the Metropolis Water Act, 1871, and to make further provision for the due supply of water to the Metropolis." It was read the first time, and ordered for second reading on the 28th prox. It is the Bill promised by the honourable member last year, and fully noticed in the "JOURNAL" for Oct. 18 (p. 875), from a print supplied by him.

On Thursday, Mr. James Stuart asked the First Lord of the Treasury whether he could give any indication of the probable date at which the House might expect to be in possession of any further report from the Royal Commission on the London Water Question. Mr. Balfour replied that he had been informed that the Commissioners were at present unable to fix any date for the presentation of their second report; but that there would be as little delay as possible after the taking of evidence was concluded.

Mr. Harwood has given notice of his intention to ask the First Commissioner of Works to-morrow if it is contemplated to allow Kensington Gardens to be cut up for the passage of water-mains.

LEGAL INTELLIGENCE.

A Serious Gas Stealing Case at Salford.

Edward Dockray, a mechanic and the licensee of the Albion Inn, Salford, was summoned, before the Salford Justices last Friday, for "fraudulently abstracting gas" supplied by the Corporation. The offence, it was proved, had been committed in the customary manner—by connecting the inlet and outlet pipes of the meter by rubber pipes. From the appearance of these pipes, Henry Baxter, one of the Corporation gas inspectors, was of opinion that they had been in use for some time—perhaps for years—as they could be connected and disconnected in a few minutes. The old excuse was made that on Sunday night something went wrong with the gas; and so, as defendant could neither get a plumber nor send to the Town Hall, he attached the rubber pipes in order that the house might not be in darkness. But Mr. Makinson, the Stipendiary Magistrate, had no doubt the fraud had been going on for some time; and he fined the defendant £5 and costs, or a month's imprisonment.

False Entries on Time-Sheets.

At the Birmingham Quarter Sessions last Thursday, Walter Johnson (27), a gasfitter in the employ of the Corporation, pleaded guilty to having unlawfully made a false entry on a time-paper belonging to the Corporation. Mr. M'Cardie, who prosecuted, pointed out that this was prisoner's first offence, and that the prosecution did not wish to press the charge. Johnson entered on his time-sheet that he had spent 2¾ hours on Nov. 24 last, in fixing a meter at a house in Blackford Road, Sparkhill, and that he had spent 4d. in tram fares. He did not go to Sparkhill on the date mentioned. By means of the false entry he obtained from the Corporation 2s. 2d. in excess of what he was entitled to. The Corporation were determined to put down the practice of falsifying the sheets; and the suggestion that prisoner should be bound over under the First Offenders Act could not be taken as a precedent. The Deputy Recorder (Mr. T. S. Soden) thought it was a case in which he could take the course suggested; and he bound the prisoner over to come up for judgment when called upon. He, however, said it was a most serious offence; and he should deal in the future more severely with similar cases.

Laying Mains Without Notice.

At the South-Western Police Court last Thursday, Mr. Lane, Q.C., heard an adjourned summons taken out against the County of London Brush Electric Lighting Company for breaking up and opening the pavement of Trinity Road, Wandsworth Common, without having previously given notice in writing to the Battersea Vestry. The case was commented upon in the "JOURNAL" for the 7th inst., and is noticed elsewhere to-day. Mr. W. W. Young, Solicitor to the Vestry, prosecuted; the Company were represented by Mr. Moyse. The evidence given on a previous occasion was that the Company's workmen opened the pavement in the dead of night, and put in their main. After the adjournment the Vestry applied to the High Court of Justice for an injunction to compel the Company to remove the main. Mr. Justice Jeune granted the application; but his decision was reversed on appeal. Mr. Young said that, although the injunction was refused, the action of the Company was characterized as a "high-handed proceeding." Mr. Moyse admitted the allegation, but stated that Lord Justice Vaughan Williams thought the Vestry had acted unreasonably, as there had been very little interference with their rights when once the road was laid open. Mr. Lane said it seemed to him that the Company wanted to do the same as had been done in international matters lately, and take effective possession with utter disregard to the legal question involved. He imposed a penalty of £2, with £2 2s. costs.

Another Conviction for Unauthorized Main-Laying.

At the Spelthorne Petty Sessions on Monday last week, the Sunbury Gas Company were summoned by Mr. G. W. Manning, Surveyor to the Staines District Council, for breaking up High Street and Hanworth Road, Feltham, on the 19th ult., without giving notice to the Council. Evidence having been given as to the alleged offence, the Company's Manager (Mr. Bark) was called. He said he had been at the gas-works for a considerable time, and notice had never before been given as to the breaking up of the roads at Feltham. Mr. Lodge, a Director of the Company, said they had for years been accustomed to open the roads for laying mains and making connections to the houses, and no question had ever been raised about it until lately. He believed the Company had been told by the Parish Council to go on with the work. The Chairman of the Bench (Mr. J. Ashby) said the Company must go to the Council, who would be pleased to refund all the costs to which they had been put. Fines of £1 and 7s. costs and £3 and 7s. costs were inflicted.

MISCELLANEOUS NEWS.

HOME OFFICE INQUIRY INTO THE SUPPLY OF WATER-GAS.

Conclusion of the Committee's Labours—Report and Recommendations.

The Departmental Committee which was appointed on Feb. 9 last year, by the Secretary of State for the Home Department (the Rt. Hon. Sir Matthew White Ridley), to inquire into the question of the supply of water gas, have finished their labours; and their report was presented to both Houses of Parliament on the 8th inst., and issued to the public last week. Soon after the Committee set to work, we were enabled to announce the names of the gentlemen who had been selected to carry out this important investigation, and also to indicate the scope of their inquiry. The report being prefaced by the exact terms of the "Warrant of Appointment" (which is signed by Sir Matthew White Ridley), we reproduce them: "I hereby nominate and appoint Henry, Lord Belper, Henry Hardinge Samuel Cunynghame, Esq., Assistant Under Secretary of State for the Home Department, John Scott Haldane, Esq., M.D., F.R.S., Henry Franklin Parsons, Esq., M.D., Assistant Medical Officer of the Local Government Board; and, William Ramsay, Esq., Ph.D., F.R.S., Professor of Chemistry, University College, London, to be a Committee to inquire into and report upon—(1) The extent to which water gas and other gases containing a large proportion of carbonic oxide are manufactured and used for heating, lighting, and other purposes; (2) the danger attending such manufacture and use; (3) the means by which such dangers may be removed or diminished either by the discontinuance of the use of such gas or gases or otherwise; and what regulations for the prevention of danger should be established. I further appoint Lord Belper to be Chairman, and John Pedder, Esq., of the Home Office, to be Secretary of the said Committee."

Altogether the Committee have had twelve sittings for the reception of evidence—the first being held on March 1 last year, and the final one on Nov. 28. During that period, they had before them twenty-four witnesses, whose evidence occupies seventy foolscap pages of small print. The witnesses (their names being given in the order of examination) were: Mr. A. G. Glasgow, of Messrs. Humphreys and Glasgow; Mr. George Livesey; Professor Frank Clowes, D.Sc.; Mr. John Tatham, Statistical Superintendent of the General Register Office; Professor Vivian B. Lewes; Dr. C. D. Hill Drury, of Darlington; Sir Henry D. Littlejohn, Medical Officer of Health for Edinburgh; Dr. E. W. Hope, Medical Officer of Health for Liverpool; Mr. William King, Engineer of the Liverpool Gas Company; Sir Henry Roscoe, F.R.S.; Mr. Frank Scudder, F.I.C., F.C.S.; Mr. C. R. Bellamy, Superintendent of Street Lighting to the Corporation of Liverpool; Mr. G. C. Trewby, Consulting and Constructing Engineer to The Gaslight and Coke Company; Sir Edward Frankland, K.C.B., F.R.S.; Dr. J. A. Fisher, Medical Officer of Health for Garston; Dr. Arthur Newsholme, Medical Officer of Health for Brighton; Mr. Joseph Cash, Engineer and Manager of the Brighton and Hove Gas Company; Mr. J. T. Westcott, of the Economical Gas Apparatus Construction Company, Limited; Mr. Alex. C. Humphreys, of Messrs. Humphreys and Glasgow; Mr. Isaac Carr, Engineer of the Widnes Corporation Gas Works; Mr. James Stelfox, Engineer and Manager of the Belfast Corporation Gas Works; Mr. Corbet Woodall; Mr. Thomas Holgate, Engineer of the Halifax Corporation Gas Works; and Dr. Arthur Whitelegge, Chief Inspector of Factories. An abstract of the evidence of the witnesses is being prepared, and will appear in succeeding issues of the "JOURNAL." The text of the Committee's report (which is commented upon elsewhere, see pp. 427, 432) is given below. It is accompanied by seven appendices, comprising: (1) A Memorandum by Dr. Haldane, on "The Mode of Occurrence of Poisoning by Illuminating Gas;" (2) a Memorandum by Dr. Parsons, on "The Use of Water Gas in the United States of America, with reference to its effect on Public Health;" (3) Tables of Deaths from Gas Poisoning in 1896, 1897, and 1898; (4) Table of places where Carburetted Water Gas is used, with opinions of Local Authorities; (5) Table giving the Carbonic Oxide in Various Samples of Gas, by Professor Ramsay; (6) Miscellaneous Papers referred to in the Evidence—viz., Reports by Sir Henry Littlejohn and Sir Henry Roscoe, and Statement by Mr. Alex. C. Humphreys; (7) Memorandum by Dr. Lorrain Smith on "The Poisonous Action of Coal Gas and Carburetted Water Gas."

THE COMMITTEE'S REPORT.

We have inquired into the questions relating to gases containing a large proportion of carbonic oxide which you have referred to us; and we now submit our report.

We have heard evidence from several leading gas engineers in this country and America, from the most important of the towns where such gases are in use, and from several medical and scientific authorities; and we have ourselves visited works where carburetted water gas is made, and have had an opportunity of examining the process and the nature of the gas produced.

Apart from ordinary coal gas, which itself may contain no inconsiderable proportion of carbonic oxide, the gases to which our consideration has been specially directed for the purposes of this report may be included in the term "water gas," subject to the distinction of being "carburetted" or "non-carburetted." There are in addition certain forms of producer gas, Dowson gas, &c., used for industrial purposes, which, though containing a large proportion of carbonic oxide, do not appear to demand special investigation, and are treated shortly at the end of this report.

We deal first and—for reasons which will appear in the course of the report—in greatest detail with

Carburetted Water Gas.

Pure water gas, which is made by passing steam through heated coke or anthracite coal, burns with a non-luminous flame, and has no smell. For lighting, and in some degree also for heating, purposes it is necessary to enrich the gas with oil. In this process, which is known as "carburetting," the oil is vaporized, and thoroughly incorporated with the gas, thereby giving its flame luminosity, and also imparting to the gas a decided smell, similar to, and fully as noticeable as, that of ordinary coal gas. The manufacture and distribution of carburetted water gas for ordinary public and domestic lighting and heating purposes is stated to have begun in America about the year 1878. In England, the year 1891 appears to have been the date of the first considerable installation of carburetted water-gas plant. Originally the main object in the United Kingdom of making carburetted water gas appears to have been the enrichment of coal gas—*i.e.*, the increasing of its candle power. Latterly the question has become one of production even more than of enrichment; and though in England, except in one instance for a limited period, no gas producer has made a practice of distributing carburetted water gas unmixed with coal gas, in America pure carburetted water gas is very commonly used.

Extent of Use.

In the United States, about 70 per cent. of all the illuminating gas supplied was, in 1896, carburetted water gas; and we are informed that the distribution of this gas is still increasing rapidly. In Great Britain, there is at the present time plant capable of making between 70 million and 80 million cubic feet of carburetted water gas per day. If this plant were worked to its full capacity every day in the year, it would produce an amount of gas equal to about 24 per cent. of all the illuminating gas supplied in the year 1897-8 in Great Britain. But it is not always in full operation; and therefore its actual output must be much less than that percentage. At the same time, as water gas appears to be distributed in only a comparatively small number of towns, the proportion of it in the supply of any particular place is often much higher than 24 per cent. For instance, as much as 50 per cent. appears to be ordinarily used at Tottenham and Edmonton; while the proportion is given in the Board of Trade Returns as having been, on occasion, as high as 64 per cent. in Birkenhead, 60 in Belfast, and 43 in Brighton, and over some part of London it may often be 33 per cent.

It has been stated that, in the ordinary course of events, every year will show an increase in the amount of carburetted water gas supplied, subject to the variations in the relative values of oil and coke and other commercial considerations. The experience of America supports to some extent this anticipation, though certain conditions in that country—such as the cheapness of oil in many places and the abundance of anthracite as compared with bituminous coal—are specially favourable to an increase in the manufacture of water gas.

The advantages claimed for carburetted water gas have been put before us by many witnesses. They will be found set out briefly in the statement of Mr. Glasgow in the first day's evidence. On the other hand some witnesses questioned the economy effected by the installation of water-gas plant; and the alleged difficulties in getting the required candle power and flexibility of supply from coal gas. We are, however, satisfied that the advantages which many gas managers see in carburetted water gas may well lead to an increase in its use.

It may be observed that, according to the Board of Trade Returns for 1896, there were seven Local Authorities and twelve Companies making water gas; while the Returns for 1897 indicate that in ten of those nineteen cases the proportion of this gas used has risen, and also record eight additional Companies and four Local Authorities as making water gas.

We do not propose to discuss the economic advantages and disadvantages of water gas; but we think it right to draw attention to one point which may be of very considerable importance to the general public. It may be called the emergency value of water gas. A sudden increased demand for gas occasioned by fogs or other unforeseen occurrences can be met only—in default of great storage—by putting into operation reserve plant. If coal-gas retorts alone are available, it will take two or three days to bring them into action. If there is carburetted water-gas plant in reserve, it can be started in a very few hours, and can be made to produce gas with great rapidity.

It is to be observed that at present there appears to be no statutory obstacle to an indefinite increase in the use of carburetted water gas. Parliament has never, we believe, authorized specifically the making and distribution of this type of gas. But the terms of the Public and Private Acts under which all gas producers with statutory powers proceed, refer to "gas" without prescribing the materials or method of manufacture, and so may be taken to authorize the distribution of water gas, even though that gas was not in use when the general statutes on the subject were passed. On the other hand, where the gas producer is a local authority, and is required to obtain sanction for loans, the Local Government Board, when apprised that a loan is needed in connection with water-gas plant, have refused sanction or imposed conditions as to the proportion of water gas to be made, in view of the dangers which have been alleged to attend its use. In one case also in which a Company applied to the Board of Trade for a Provisional Order to enable them to supply plain water gas, the Board, in the interest of public safety, inserted in the Order clauses requiring the proper odorization of the gas, and imposing other special conditions. The powers given by the Order were never exercised.

Danger of Manufacture and Use.

Coal gas contains a percentage of carbonic oxide, which evidence given before us shows to vary from 4 to 12, according to the kind of coal used and the particular conditions of manufacture. Carburetted water gas contains about 30 per cent. of carbonic oxide.* Carbonic oxide ranks amongst the most dangerous of poisonous gases known. In these facts lies the *primâ facie* reason for apprehending danger from the extensive use of carburetted water gas.

As regards manufacture, the danger to the persons employed appears to be, with proper machinery and arrangements, not greater than that incurred in coal-gas making; and any danger that there may be can, we think, be dealt with adequately under the Factory and Workshops Acts, for the purposes of which gas-works are "Non-Textile Factories."

As regards use, the circumstances under which carburetted water gas may be seriously dangerous are comparatively few. Danger arises only when the gas escapes unconsumed; for, when burned in the ordinary way, the products of combustion of carburetted water gas are no more unhealthy than those of coal gas. The danger to be feared is not from explosion, for there is no greater likelihood of that with water gas than with coal gas, but from poisoning. In the day-time, however, the amount

* One analysis made for the Committee showed 34 per cent of carbonic oxide.

of carbonic oxide is not of serious consequence. An escape of carburetted water gas is as easily detected as one of coal gas, and, except in very special circumstances, can be avoided or remedied long before the atmosphere is in the least degree poisonous. Even at night very slight escapes of an ordinary character, caused, for instance, by imperfections in the joints of fittings, do not appear to us to be rendered more formidable by the introduction of carburetted water gas. It is practically impossible for a really poisonous atmosphere to be produced by such escapes; and though it is evident that constant exposure to small leakages of gas may be to some degree prejudicial to health, we do not think that the existence of anything like chronic poisoning by carbonic oxide has been established.

It appears, then, that the prospect of any serious result from the distribution of gas containing a high proportion of carbonic oxide is practically confined to cases of large escapes into rooms where persons are asleep. These escapes occur owing to various accidents, such as the unnoticed turning on again of a tap which has been turned off, the blowing out of the gas-light, the extinguishing of the light by stoppage of the pipes or turning off at the meter, and the renewed flow of gas without the taps having been turned off. Fatal results have also been traced to breakages or leaks in mains and service-pipes, whereby gas has percolated—sometimes becoming deodorized—through the earth into a house; and to leaks through a wall or through a ceiling and floor from a gas pendant in the room below. In these ways, accidents have been caused in houses and rooms to which gas was not laid on.

The number of fatal accidents due to the above causes with coal gas alone is undoubtedly extremely small; but it is impossible to ascertain, with strict accuracy, the death-rate from gas poisoning in this country either before or since the introduction of water gas. The returns made by coroners vary too much in form, are too vague, and too often omit all reference to the medical evidence which may have been given. During the course of our inquiry, several deaths have occurred from poisoning by illuminating gas, under essentially the same conditions, and have been returned variously as "Accidental death," "Death by misadventure," "Death by gas poisoning" (without indicating whether or not there was carburetted water gas present), "Natural causes," and "Death by carbonic oxide poisoning." Further, there are no means of ascertaining the cases of serious injury to health due to sleeping in an atmosphere laden with carbonic oxide. Thus, though two persons were killed and five made seriously ill during the short time that carburetted water gas was supplied pure in a certain district, and though there are not a few fatal cases which were clearly caused by illuminating gas containing a greater or less proportion of carburetted water gas, no very satisfactory conclusion as to the effect in the United Kingdom of the introduction of water gas can yet be drawn from the facts and figures available.

As regards the United States, where water gas has been in use for a much longer time than in Great Britain, and has in many towns replaced coal gas, the most systematic and trustworthy statistics available are those of the State of Massachusetts, where there exists a Board of Gas and Electric Light Commissioners charged with the duty of recording and investigating accidents from gas and electric light. From the annual reports which they make to the State Legislature, it appears that in Boston in the year 1886, when the population was 390,393, and the number of gas consumers 29,554, the gas sold amounted to 1,362,711,000 cubic feet, of which none was water gas, and no accidents were recorded. In 1890, with a population of 448,778 and 46,848 gas consumers, 8 per cent. of the 1,761,199,500 cubic feet of gas sold was water gas; and there were six deaths from gas poisoning—two being suicidal. In 1895, the population had risen to 496,920, the gas consumers to 68,214, and the amount of gas sold to 1,875,952,800, of which 90 per cent. was water gas; and 24 deaths (including eight suicides) occurred. In 1897, the gas consumers numbered 79,893; the gas sold amounted to 2,354,291,900 cubic feet, containing 93 per cent. of water gas; and there were 31 accidental deaths and 14 suicides. A memorandum by Dr. Parsons on the American figures is printed in Appendix II.; and Appendix VI. 3, contains a careful examination of them by Mr. Humphreys, a leading Gas Engineer and Manager in the United States. Mr. Humphreys pointed out various reasons why the statistics ought not, in his opinion, to be implicitly trusted; but, while admitting that it may not be fair to rely absolutely on a comparison with former years, when records may have been less complete, after deducting the cases due to deliberate suicide, and making every other due allowance, we feel that the state of affairs disclosed in Boston, New York, San Francisco, and other towns is decidedly serious. As regards Boston, this is the opinion of the Gas and Electric Light Commissioners also. That Board has several times sought carefully for a remedy, but is always met with the difficulty that the practice of distributing water gas has become so widely and firmly established, and the plant has so completely superseded coal-gas plant, that to reorganize the systems of the various companies on the lines of a greater use of coal gas is practically an impossibility.

If then the danger from water gas is considerable, it is important that in this country it should be dealt with before the causes of it reach unmanageable proportions. It has been argued that, inasmuch as it has not been proved that in all places in Great Britain and in the United States, the number of deaths by gas poisoning has risen proportionately with the increase of water gas, the greater proportion of carbonic oxide in water gas may possibly not be the determining poisonous factor, that there may be other gases common to water gas and coal gas, and in more nearly equal amounts, which are responsible for the fatal effects, or that other constituents in the gases may in some way modify the operation of the carbonic oxide. No evidence was produced in support of these suppositions; and we are unanimously of the opinion (supported by the experiments detailed in Appendix VII.) that the poisonous action of coal gas and water gas is due solely to the carbonic oxide which they contain, that the higher the proportion of carbonic oxide the greater is the poisonous property of the gas, and that given equal conditions as to size of room, ventilation, flow of gas, length of exposure, &c., the danger to life from an escape of carburetted water gas or of coal gas mixed with any considerable proportion of water gas is far greater than that from an escape of ordinary coal gas. The danger, in fact, increases at a much greater ratio than the proportion of carbonic oxide.

A large number of careful and elaborate experiments and investigations which were made specially for the Committee by Dr. Haldane are described in Appendix I. The results arrived at represent the grounds upon which much of this report has been based; and the appendix will be found, we think, to afford very valuable data for calculations as to the danger under various conditions of high percentages of carbonic oxide.

Bearing carefully in mind that it is not desirable to place special restrictions upon the development or management of the trade unless, without such restrictions, some serious effect upon public safety or convenience is to be feared, we nevertheless consider that the unrestricted distribution and use of carburetted water gas would constitute a substantial danger; and we submit that it ought to be prevented.

It is to be observed that the danger is not confined to accidents. The American figures, at least, show an increasing use of gas for suicidal and even homicidal purposes. It may be argued that, in the absence of poisonous gas other means of putting an end to life could readily be found. Yet it has always been recognized that it is not desirable to give facilities for the use of deadly poisons; and the facility with which murder (particularly child murder) bearing all the appearance of accident could be committed by simply turning on in a small room a jet of gas containing a large proportion of carbonic oxide seems to us to afford an additional reason for restricting the use of carburetted water gas.

Prevention of Danger.

The most direct, and, in our opinion, the only effective method of preventing danger from water gas is to fix a limit which the carbonic oxide in a public and domestic gas supply shall not, in ordinary circumstances, exceed. It is difficult to assign a limit applicable to all circumstances. In some cases 12 per cent. of carbonic oxide in the gas supplied might be proper; in others, 16 or perhaps 20. The question depends on a number of circumstances which must vary in different localities. For instance, the style of gas-fittings in general use, and the condition of the mains and service-pipes should be considered; and an important factor is the normal pressure under which the gas is distributed at night, as this governs the rate of discharge through a burner, and consequently, to a great extent, the chance of the production of a poisonous atmosphere. A limit of 16 per cent. of carbonic oxide would allow of a mixture of between 30 and 40 per cent. of carburetted water gas, as at present manufactured, with coal gas, a proportion not now ordinarily exceeded in many cases where water gas is in use; while a limit of 20 per cent. would admit of 50 per cent. each of the two gases.

We are of opinion that, with the present conditions of gas supply, 20 per cent. is the highest proportion of carbonic oxide that should be allowed, and that this percentage should be used only under special circumstances. It will probably be found convenient to make use of local control for the purpose of prescribing some of the special conditions relating to the distribution of gas; but bearing in mind that, in many of the largest centres of population, the manufacturer of gas is the local authority itself, that where the gas is supplied by a company the districts of several local authorities may be included in the limits of supply, and that in many of the smaller districts the advice of a skilled expert may not generally be available, we think that the actual amount—beyond a certain limit—of carbonic oxide permissible in a public and domestic supply of gas should be fixed by a Central Department, according to the local circumstances.

As the chief danger from water gas arises during the hours of sleep, we think that during the day the precise restrictions as to carbonic oxide appropriate for the night need not necessarily be applied. But if the supplier of gas is allowed the advantage of greater freedom during the day, he must be responsible for ensuring that after an hour prescribed in the regulations no gas is issued containing more than the authorized night percentage of carbonic oxide. We would add that a breach of the regulations, at all events as regards the percentage of carbonic oxide, should entail a very substantial penalty, which it would not be worth the gas-maker's while to risk.

Our attention was called by several witnesses to the very imperfect and unsatisfactory gas-fittings often used in the poorer class of houses in large towns, and the constant leakages which exist without any attempt to discover or rectify them; and it has been suggested that powers might be given to Local Authorities to enable them to enforce a standard of fittings when newly put up in such houses (as is done in the case of water-fittings), and also to inspect such fittings when required. We think that such powers might with advantage be given, to be used at the discretion of the local authority. Other suggestions of the same type, with which we agree, are: (1) That in common lodging-houses and other houses similarly subject to bye-laws, the question of gas should be treated with special care, and that the local authority now responsible for these places should have the additional power of prescribing the size of burner to be used in bedrooms according to their cubic capacity; and (2) that faulty gas-fittings, particularly stoves not provided with proper flues or chimneys, should be added to the matters which may be dealt with under section 91 of the Public Health Act, 1875.

Non-Carburetted Water Gas, &c.

Water gas uncarburetted has not yet been used in this country for public or domestic lighting and heating purposes. Various forms of it, as well as producer gas, Dowson gas, &c., are employed in factories, and also for gas-engines. It is probable that this use will be greatly extended. Both the manufacture and use of these gases may entail considerable danger, since the gases are highly poisonous—containing upwards of 40 per cent. of carbonic oxide—and have little or no odour. The danger, however, is to the workpeople, not to the public; and we think that, given a knowledge of the nature of the gases, the manufacture, distribution, and use of them for industrial purposes can—with one possible exception—be dealt with under the Factory and Workshop Acts, whether by special rules or otherwise. The exception may be the case, if any, where one of these gases is not used on the premises in which it is made, but is supplied to a neighbouring factory or workshop—*e.g.*, for heating tools. No instance of this kind has come to our notice; but if it occurred, and if in this or in any other cognate case the use of such gas could not be certified as a dangerous process under the Factory and Workshop Acts, the danger must be mitigated as far as possible by bringing the gas within requirements similar to those which we recommend in the case of the public distribution of carburetted water gas.

It appears, indeed, possible that non-carburetted water gas may be introduced for heating purposes in stoves, and also, though its flame is in itself non-luminous, for lighting by means of incandescent mantles. In that case a sufficiently pungent smell should be required to be given

to the gas to render any escape easily noticeable. This can be done at small expense, and with no difficulty, by means of various chemical substances. The gas should also be placed under strict regulations. These regulations may possibly be similar as regards many points to those which we have recommended for carburetted water gas; but we desire to say that other points will probably require further consideration when the exact nature of the gas, and the proposed methods of supplying it, are known.

Summary and Recommendations.

To sum up, we have come to the conclusion that, if the accidents attributable to water gas are not yet very numerous in Great Britain, the reason is that the proportion in which this gas has been used has not hitherto, except in a few instances, been high. A large increase in the use of the gas is, however, to be expected in several localities; and in some places the use of pure carburetted water gas is contemplated, in the absence of legislative restriction.

We therefore think the present time opportune for dealing with the matter, before the manufacture of water gas is established on a larger scale; and we beg to submit the following recommendations, to which, if approved, effect should, in our opinion, be given by a Public Bill:—

1. That it should be illegal for any person to make and distribute for heating and lighting purposes any poisonous gas which does not possess a distinct and pungent smell.
2. That all persons applying for statutory powers to make and distribute gas should be required to state in their application the kind of gas which they propose to sell—viz., whether ordinary coal gas, carburetted water gas, plain water gas, or other variety of gas, separately or mixed.
3. That before any kind of water gas is distributed in any place, due public notice of the proposal should be required to be given; and that, as long as there is any water gas in a gas supply, that fact should be stated on every demand note.
4. That, where water gas is distributed, records should be kept by the producer, showing the respective amounts of the gases issued day by day, distinguishing the gas supplied to each area (if more than one and separately served), and the day and night supply; that these records should at all times be open to inspection by any gas consumer or ratepayer of the district, and should be published quarterly in a local newspaper; and that a new column should be added to the annual returns made to the Board of Trade, giving the total amount of water gas issued, as compared with coal gas.
5. That power should be conferred upon a Central Department to make regulations, enforceable by adequate penalties, limiting the proportion of carbonic oxide in the public gas supply at night to 12 per cent. or such greater amount as the Department may consider desirable. These regulations might be applicable either generally over the United Kingdom or to any particular locality, and might contain such conditions, if any, as appeared necessary. (The considerations which may govern the fixing of the limit of carbonic oxide are indicated under the heading "Prevention of Danger" and in Appendix I.)
6. That powers should also be given for the regulation of the distribution and use of gas by means of bye-laws, made subject to the approval of a Central Department and administered under local control. The matters to be so dealt with might include the following: The hours during which, or the arrangements by which, the limit imposed upon carbonic oxide should be enforced, the use in emergencies of more than the authorized proportion of carbonic oxide, the character of the gas burners, fittings, and apparatus to be used, having regard to the circumstances of their employment, the testing of the gas, and similar questions.
7. That the provisions of Sections 28 to 34 of the Gas-Works Clauses Act, 1871, should be made applicable to the testing of gas for carbonic oxide, and that, in all cases where a limit has been placed upon the carbonic oxide in the gas supply of a locality, there should be some person empowered and required to test for carbonic oxide, and to publish the results periodically.

Lastly, we are so much impressed by the insufficiency and untrustworthiness of the statistics relating to particular causes of mortality which can be gathered from returns of Coroners' verdicts, that we venture, though the matter is outside the terms of the reference to us, to recommend strongly that some steps should be taken to secure that these verdicts should lend themselves more readily to clear classification by the Registrar-General; and, in particular, we suggest that in every case where the Coroner is in possession of a medical certificate of death, or where medical evidence has been taken at the inquest, a copy of that certificate, or an abstract of that evidence, should be appended to the Coroner's Certificate when sent to the Registrar-General.

Our thanks are due to our Secretary, Mr. Pedder, for the great assistance rendered by him during the inquiry.

[The report is signed by all the five members of the Committee, and is dated Jan. 17, 1899.]

APPENDIX I.—The Mode of Occurrence of Poisoning by Lighting Gas.* By Dr. Haldane.

The present appendix, which has been drawn up at the request of the Committee, contains an analysis (based partly on such evidence of witnesses and published records as were available, and partly on experiments) of the mode of occurrence of poisoning by lighting gas.

The Cause of Death in Poisoning by Lighting Gas.

The general composition of coal gas, and of several varieties of carburetted water gas, are shown in the analyses quoted by Mr. Glasgow in the first day's evidence. About 80 per cent. of the coal gas and 60 per cent. of the carburetted water gas consists of hydrogen, marsh gas, and nitrogen, which are definitely known to have no poisonous action. The chief additional constituent is the very poisonous gas carbonic oxide, of which there is usually about 6 or 8 per cent. in English coal gas, and about 30 per cent. in English carburetted water gas. Among competent authorities, carbonic oxide is generally held to be the poisonous constituent of both coal gas and carburetted water gas, and for all practical purposes the only poisonous constituent. The grounds for this opinion are as follows:—

1. When animals are poisoned by coal gas or water gas, both the symptoms and the postmortem appearances are those of carbonic oxide poisoning. These appearances are definite and unmistakable, as carbonic oxide produces a characteristic change of colour in the blood.

2. In numerous cases where human beings have been poisoned by coal gas or water gas, the same appearances have been observed; and in four of the cases which occurred during the sittings of the Committee, not only were the usual appearances observed, but analyses showed that the changes corresponded exactly to those known to occur in cases of pure carbonic oxide poisoning.

3. Coal gas, when as far as possible deprived of its carbonic oxide by passing it through cuprous chloride solution, has only a very slight action on animals, and the same is true of oil gas, which contains little or no carbonic oxide, but is otherwise more or less similar in composition to coal gas and carburetted water gas. In his official report for 1884, as State Inspector of Gas for Massachusetts, Mr. Hinman describes experiments in which he kept animals without harm in air containing so much oil gas that it burned quietly, and was not even explosive.

4. In consequence of the peculiar mode of action of carbonic oxide, its poisonous action is abolished in presence of oxygen at high pressure, and partly abolished in presence of oxygen at atmospheric pressure. The same abolition of the poisonous action of coal gas is observed under the same circumstances. If the coal gas is present in very large excess, the other constituents begin to have a slight action; but this action is unappreciable when the gas is only present in proportions which are just poisonous in ordinary air.*

5. The symptoms of poisoning produced by a given proportion of coal gas appear to correspond with those due to the carbonic oxide present in the gas. Thus, in the course of the experiments described below, I occasionally took mice into the room with me, and watched their symptoms. So far as I could judge, these symptoms corresponded as exactly as possible to the percentage of carbonic oxide present. Had the same percentage of carburetted water gas as there was of coal gas been present in the air, these animals would undoubtedly have died of carbonic oxide poisoning; and I myself should have been quite unable to make deliberate observations with safety lamps, mice, &c., on the air, and continuously proceed with the analyses during the intervals of observation. There is also clear evidence in the experiments made by Professors Sedgwick and Nicholls for the Massachusetts Board of Health that carburetted water gas is much more poisonous than coal gas. In order, however, to clear up any doubts which might remain on this question, Dr. Lorrain Smith was requested by the Committee to investigate the matter; Mr. Stelfox, C.E., Engineer of the Belfast Corporation Gas-Works, where water gas is made, having offered to co-operate in the experiments. The results are given in another Appendix, and furnish conclusive evidence. (Appendix VII.)

Nature and Degree of the Poisonous Action of Carbonic Oxide.

The oxygen absorbed in the lungs from the air is normally taken up by the blood in the form of an unstable chemical compound with the red colouring matter (hæmoglobin) of the blood, and so carried by the circulation to the tissues, where it is used up. Hæmoglobin not only combines with oxygen, but forms a much more stable compound with carbonic oxide; and hæmoglobin which is saturated with carbonic oxide cannot take up oxygen. In proportion, therefore, as the carbonic exide compound is formed, the blood loses its power of carrying oxygen from the lungs to the tissues; and death from want of oxygen finally ensues. It will be readily understood, however, that, since oxygen as well as carbonic oxide has an affinity for hæmoglobin, the extent to which the latter substance can become saturated with carbonic oxide will depend on the relative proportions in which oxygen and carbonic oxide are present in the air. The one gas tends to drive the other out from the hæmoglobin; and the final result is an expression of the balance struck between the two conflicting processes. If the percentage of carbonic oxide in the air is so high that too little of the oxygen compound can be formed to support life, then death ensues. If, on the other hand, the person or animal is removed to fresh air before death occurs, then the carbonic oxide is, in the course of several hours, turned out of the hæmoglobin and eliminated in the breath. If, finally, the person or animal remains exposed to a moderate percentage of carbonic oxide, the blood ceases after a certain time to take up more carbonic oxide.

The symptoms caused by a gradual cutting off of the oxygen supply to the body, as in carbonic oxide poisoning, are very insidious in their onset, and in some ways have a curious resemblance to those of alcoholic poisoning. Sometimes there is drowsiness, and sometimes great exhilaration or quarrelsomeness. Mental, muscular, and sensory co-ordination are all much affected, though the person under the influence of carbonic oxide is often unaware of anything being wrong until complete helplessness supervenes. Persons who are asleep when exposed to carbonic oxide, often do not awake at all, or not until they are too helpless to escape, or too much stupefied to make the attempt to do so.

Air containing about 0·4 per cent. of carbonic oxide by volume suffices to cause death in warm-blooded animals of various kinds; and there is every reason to believe that the same percentage would prove equally fatal to men. An exposure of about an hour, or a little more, would probably be about the minimum time to cause death in the case of a person asleep. Death may sometimes, however, occur in the case of animals with as little as 0·2 per cent. of carbonic oxide, provided the exposure has been long enough, or in case of any sudden muscular exertion; and doubtless the same holds good for men. From the records of various cases of coal gas poisoning, it would seem as if death had frequently occurred in consequence of the exertion of attempting to reach a door or window, or even of putting on clothes. Sudden exposure to cold has a similar dangerous effect. It would thus appear that anything more than 0·2 per cent. of carbonic oxide in air ought to be regarded as entailing risk to life. Air containing less than 0·05 per cent. of carbonic oxide causes in a healthy person no effects beyond giddiness or exertion, however long the exposure may be.

* We have not reproduced the mass of tabular information accompanying this appendix; but Dr. Haldane's deductions clearly indicate its nature.

* "British Medical Journal," Oct. 3, 1896.

The after-symptoms of carbonic oxide poisoning are often of a very serious nature. It must be remembered that during the period when the oxygen supply to the tissues is diminished, they may undergo serious damage, and that the effects of this damage may remain for long after all the carbonic oxide has been eliminated. The headache and nausea which commonly follow exposure to carbonic oxide are one sign of slight temporary damage. Often, however, far more serious signs are met with. In many cases of long exposure, consciousness never returns, although the blood is quite free of carbonic oxide; in other cases serious mental symptoms remain for a long time; in others there are symptoms of formidable affection of the heart-muscle; in others, fatal pneumonia supervenes after a day or two. In the after-treatment of carbonic oxide poisoning, too much care cannot be exercised, on account of the probability of some organ or another being seriously damaged, and ready to break down entirely unless it is given complete rest.

Post-Mortem Appearances in Coal Gas and Water Gas Poisoning.

The post-mortem appearances in coal gas and water gas poisoning are very characteristic, provided the person has died in the poisonous atmosphere. As the compound of carbonic oxide with hæmoglobin has a bright red colour, whereas the uncombined hæmoglobin present after death from other causes is dark purple, the blood is more or less red, and all the organs of the body are red, instead of purple or bluish, when first exposed. The red colour can often be seen very distinctly on the lips, tongue, skin, &c., though they may be pale, in which case the cause of death is not so evident. A similar red colour may, however, occasionally be produced in exposed parts of the skin by the mere action of the oxygen of the air. A sample of the blood should always be taken. This may easily be obtained by squeezing blood from a vein, such as the external jugular, if it is not practicable to make a complete examination of the body. A few drops of blood are sufficient; and if the tests cannot be made at once, the blood may be placed in a tube or small bottle, which, if not filled with blood, should be filled full of water and securely corked. The sample will then keep indefinitely, provided no air is allowed to enter. In presence of air, the hæmoglobin is soon altered; whereas in the absence of air, it keeps indefinitely. Samples of blood which I obtained from some of the bodies of men killed by carbonic oxide in colliery explosions three years ago have, for instance, remained quite unaltered as regards their hæmoglobin since that time.

To test the blood for carbonic oxide, both the easiest and the most delicate method is to compare the tint of a greatly diluted solution in ordinary water with that of normal blood similarly diluted. A solution of normal blood so highly diluted that, when placed in a test-tube, it looks yellow, is first prepared. One portion of this solution is placed in a test-tube, and shaken up for a few seconds with coal gas. This is introduced into the test-tube through a piece of rubber tubing; the top of the test-tube being quickly closed with the thumb as the tubing, with the gas flowing through it, is withdrawn. The solution, after shaking with the coal gas, will have the pink colour characteristic of the compound of carbonic oxide and hæmoglobin, when in dilute solution. Another portion of the normal blood solution is placed in a second test-tube (of similar width). A portion of the suspected blood is placed in a third tube, and then gradually diluted with water till its depth of colour is about the same as that of the first two tubes. The tints of the three tubes are now compared. If the suspected blood contains no carbonic oxide, its tint will be that of the normal blood. If carbonic oxide be present, the tint will more and more nearly approach that of the blood saturated with carbonic oxide, according as the hæmoglobin is more and more completely saturated with carbonic oxide; and a rough quantitative estimate of the degree of saturation may readily be made. In cases of gradual poisoning by carbonic oxide, death usually occurs in man at about 60 to 80 per cent. saturation of the hæmoglobin with carbonic oxide. In five recent cases of gas poisoning at Belfast (October, 1898, and Jan. 3 and 10, 1899) post-mortem examinations were carried out by Dr. Lorrain Smith; and the blood (samples of which were also examined by myself) was 83 per cent. saturated in the first case, 76·6 and 69·5 per cent. saturated in the second two cases, which occurred together in the same room. The last two cases also occurred together, but one of the two persons poisoned survived for three-and-a-half hours after removal from the room. The blood was practically free from carbonic oxide (5 per cent. saturated), while the blood of the other person—an old woman—who was dead when found, was 57 per cent. saturated. There could thus be no shadow of doubt, not only that carbonic oxide was present in the blood, but that carbonic oxide poisoning was the actual cause of death in these cases.

For the colour test, a good light is necessary. It is best to hold the test tubes up towards a window; but an opal lamp-globe, particularly if the light is from an incandescent gas-burner, serves almost equally well if daylight is not available. If a spectroscope is available, the better-known spectroscope test may also be applied to the blood. But this test is not so delicate; and unless the hæmoglobin is more than 40 per cent. saturated with carbonic oxide, the test is useless.

When death occurs within more than three or four hours after the person has been removed from the poisonous atmosphere, little or no carbonic oxide is likely to be found in the blood; and the cause of death can only be inferred from the history of the case. If death occurs very rapidly from exposure to a high percentage of carbonic oxide, the venous blood will be found to be only very partially saturated with carbonic oxide; and probably there will be appearances of great venous congestion of the face, neck, &c., with blood of a purple colour, as in cases of acute asphyxia from other causes. Such appearances may be expected in cases of suicide from inhaling nearly pure coal gas, accidents to workmen at gas-works, or in repairing mains, &c.

Relation between Frequency of Asphyxia from Gas Poisoning and Percentage of Carbonic Oxide in the Gas.

The data given in the appendices by Dr. Parsons (II.) and Mr. Humphreys (VI. C.) and in the Massachusetts Commissioners' Reports, render it possible to frame some estimate of the rate at which deaths from gas poisoning have increased with the percentage of carbonic oxide in the gas. Such an estimate must be based upon the number of deaths in proportion either to the amount of gas consumed or to the population, in various towns. For American towns particularly, the first method of estimation is preferable, as the gas consumption per person varies widely. In Chicago, for instance, the gas consumption per person is little more than half that of London or New York. To render the data readily intelligible, it is also desirable to refer them to some easily understood standard; and for this country, at least, perhaps the best standard is a gas consumption, or a population, equal to that of London. Hence in Table 1, the figures are calculated for a gas consumption (that of London for 1896) of 32,000 million cubic feet, and a population of 6 millions. Unless some such standard be taken, undue importance may perhaps be attached to the experience obtained in connection with small distributions of gas. Thus, to take one example referred to in the evidence, in Pittsfield—a rapidly-growing town in Massachusetts—only one fatal case of poisoning is reported since 1891, when pure carburetted water gas was introduced; and the case of Pittsfield was quoted as an instance of safe distribution of water gas. The annual sale of gas amounted, however, to only about 14 million feet during this time; and if the death rate be calculated to the standard of London gas distribution, the result is 330 deaths a year.

The statistics furnished by Dr. Tatham afford a basis for an approximate calculation of the number of deaths from poisoning by pure coal gas in this country. As a check on their completeness, the cases recorded for 1896 and 1897 have been compared with those recorded in the "Journal of Gas Lighting," and inquiries have been made by the Secretary of the Committee with regard to a large number of the deaths returned simply as "suffocation," without further details which would exclude coal-gas poisoning. The result has been that no further cases of poisoning by purified coal gas could be discovered. It may therefore be inferred that, in spite of the unsatisfactory manner in which the causes of sudden death are often returned to the General-Register Office, the list of cases furnished to the Committee is in all probability pretty complete. It is certain, however, that many of the deaths reported were not due to illuminating gas itself. Thus out of the 52 deaths returned as due to coal gas and carbonic oxide in 1896 and 1897, there occur two deaths which were due to the very poisonous products of imperfect combustion of coal gas, and seventeen deaths from gases in iron-works, Dowson gas, coke fumes, &c. Then, again, it seems likely that the increase in the annual number of deaths since 1892 has been due, largely at least, to the admixture of water gas. Apart from the cases just mentioned, the majority of the deaths reported for 1896, 1897, and 1898 have occurred in the comparatively few towns, including London north of the Thames, where water gas is added to the coal gas. The increased consumption of gas would not by itself account for the increase of deaths during the last five years. Probably, therefore, the figures for 1886-91 give most nearly the average annual deaths from pure coal gas. This average amounts to only about eleven a year, or seven a year if a deduction be made for deaths probably due to products of imperfect combustion, &c.—a surprisingly small number. The average annual amount of gas consumed in England and Wales during the same period was about 80,000 million cubic feet.

Table 1.

Place.	Kind of Gas Distributed.	Annual Deaths by Gas Poisoning for a Gas Distribution equal to that of London in 1896.		Annual Deaths by Gas Poisoning for a Population equal to that of London (6 millions).		Years.
		Total.	Accidental.	Total.	Accidental.	
England and Wales	Coal gas	3·0	3·0	3	3	1886-91
England and Wales (outside London)	Coal gas only	4·2	3·4	—	—	1896-8
England and Wales (outside London)	Coal gas partly mixed with water gas	10·4	9·5	—	—	1896-8
88 American towns	Coal gas	—	—	3	—	1875-85
Boston	90 per cent. water gas	620	460	520	390	1896-7
New York	80 per cent. (?) water gas	275	130	263	124	1896-7
Brooklyn	97 per cent. water gas	400	215	235	120	1896-7
Chicago	100 per cent. water gas	—	305	—	155	1890-2
San Francisco	70 per cent. (?) water gas	—	—	940	270	1895-7
Philadelphia	38 per cent. water gas (not mixed?)	240	122	172	87	1896-7
Baltimore	100 per cent. (?) water gas	—	—	120	—	1895-6
Washington	100 per cent. (?) water gas	—	—	295	175	1896-7
Toronto	50 per cent. water gas (mixed)	45	—	32	—	?-1897.

From the table it is evident that by no possibility can the conclusion be avoided that the distribution of carburetted water gas without any special precautions is enormously more dangerous, or, to speak more correctly, less safe than the distribution of coal gas. Roughly speaking the loss of life arising in one way or another—accident, suicide, or homicide—appears to be fully a hundred times greater with water gas in America than with coal gas in this country. While coal gas is an exceedingly safe, as well as cheap, good, and convenient illuminant, water gas as distributed in America is very far from being safe.

It is somewhat difficult to convey a concrete idea of the average risk from gas poisoning run by, for instance, an inhabitant of Boston; but this risk is certainly very appreciable. Assuming that Boston has a death rate equal to that of London, about one in every three hundred deaths is due to accidental water gas poisoning. This represents an annual death-rate about the same as that of "child-birth" or of "suicide," as returned in the official statistics for England and Wales for 1880 to 1890. The total death-rate for poisoning of every kind in this country, whether accidental or suicidal, and whether by solids, liquids, or gases, is only about half the average death-rate from water gas poisoning alone in Boston, New York, San Francisco, and Washington.

In dealing with the very limited statistics available for English towns in which water gas has been partially introduced, I have left London out of account, as the admixture of water gas has been very limited, and several companies have distributed none. All, or nearly all, the recent deaths seem, however, to have occurred in districts where an admixture of water gas was probable. There certainly seems to be nothing in the experience of this country to lead to any other conclusion than that a general introduction of pure carburetted water gas would, unless the engineering difficulties connected with its safe distribution were properly met, as almost undoubtedly they might be, lead to a loss of life corresponding to that in America. The rate for accidental cases of poisoning, both fatal and non-fatal, was, to judge from the evidence placed before the Committee, quite as high in the Garston district during the period of about twenty months when pure carburetted water gas was being distributed, as in Boston.

In one respect at least, the question as to the safety of water gas, supposing its general introduction to be economically possible, would be a more serious one in this country than in the United States; for, although the population of the United States is about double that of Great Britain, the average consumption of gas per person in the United States is only about a fourth of that in Great Britain. The gas consumption of London alone is more than half that of the whole United States. The probable annual loss of life from the almost complete substitution of water gas for coal gas in the United States may be roughly estimated at about 800; so that the corresponding loss of life in this country with an equally reckless distribution of water gas would be about 1600. Further, if the various analyses available are to be trusted, it would seem that the somewhat low candle-power gas usually distributed in this country contains more carbonic oxide than the higher candle-power American gas.

The average percentage of carbonic oxide in coal gas may apparently be taken as about 7, and in American carburetted water gas as usually about 26.* It would thus seem that the increase of about four times in the percentage of carbonic oxide is attended with an increase of about fifty or a hundred times in the probability of fatal accidents. Roughly speaking, therefore, it seems probable that the increased loss of life by accidents has been about proportional to the cube of the relative increase in the proportion of carbonic oxide—64 being the cube of 4. This rule would seem to be borne out by the case of Toronto, where, with a mixture of about equal parts of coal gas and water gas (which mixture would contain only about two-and-a-half times as much carbonic oxide as coal gas) the cases of poisoning appear to be only about fifteen times as frequent, in proportion to gas distributed, as in England; and, so far as it is possible to judge from the very partial information available in the case of towns in the United Kingdom distributing water gas, experience in this country also points in the same direction. According to this rule, a given amount of water gas may evidently be distributed when mixed with coal gas far more safely than when distributed unmixed. In most American towns, however, where water gas and coal gas are both distributed, very little attention seems to have been paid to the difference as regards public safety between the distribution of the two gases mixed and their distribution unmixed.

Circumstances under which Cases of Poisoning occur when Carburetted Water Gas is Employed.

In order that the engineering difficulties connected with the safe distribution of carburetted (or uncarburetted) water gas may be successfully overcome, it is essential to understand the causes of the numerous fatal accidents which have been associated with its use in America; and the present and succeeding sections of this appendix will be devoted to an analysis of these causes.

It is very evident, in the first place, that the mere increase in the percentage of carbonic oxide in carburetted water gas, as compared with coal gas, does not by itself explain the increased number of accidents and suicides. Both kinds of gas are very poisonous from carbonic oxide, and carburetted water gas contains only about four times as much carbonic oxide as coal gas; yet in actual practice carburetted water gas has proved to be fifty or a hundred times as dangerous as coal gas.

Table 2 contains an analysis of the circumstances under which death occurred in the 231 fatal cases described in the Massachusetts Commissioners' Reports during the last eight years. Practically the whole of these deaths were caused by carburetted water gas, either pure or diluted to some extent with coal gas. Four-fifths of the accidents were caused by escapes from single burners. These escapes arose in almost every case from failure to turn off the gas on going to bed. In three or four cases, however, the accident occurred in the evening; the person having gone to sleep on a sofa or chair. It is probable that occasionally the gas was blown out through ignorance, or was extinguished by some accidental cause when left burning; but there can be little doubt that, in the great majority of cases, the tap was accidently turned on again after being turned off. Of the suicidal deaths three-fourths were brought about by the very simple means of opening one or two gas-taps. In the majority of cases, only one gas-tap was opened. It is quite clear from the reports that it was very often impossible to say with certainty whether death was due to accident or suicide. Suspected homicidal cases seem, however, to be very rare in Massachusetts, though they appear to be increasing in number in several of the large American towns.

As the great majority of the deaths caused by water gas are due to escapes from single burners during the night, special attention must be directed to the conditions which make these escapes so serious when water gas is used. Assuming that an escape of gas occurs from a burner, it is clear that four factors have to be taken account of in determining whether the air of the room will, after a sufficient time, become dangerous to any person remaining in it. These factors are: (1) The rate of escape from the burner, (2) the rate at which the air of the room is changed by ventilation, (3) the distribution of the gas in the air of the room, and (4) the percentage of carbonic oxide in the gas. Where exposure to the vitiated air is of limited duration, the size of the room is also of importance; but with a bedroom of ordinary size, and exposure during a whole night, the size of the room, as will be shown below, is not in itself of primary importance.

As existing knowledge with regard to factors 1, 2, and 3 is very imperfect, I have carried out, chiefly at the Physiological Laboratory, Oxford, a number of experiments on the subject.

Experiments on the Rate of Escape of Gas from Ordinary Burners.

In the "fish-tail" burner most commonly used in bedrooms in this country, the flat sheet of flame is produced by the impingement against one another of the jets of gas issuing from two holes in the burner. To burn the gas to the best advantage with a burner of ordinary size, the tap should be so regulated that the pressure at which the gas issues is limited to about $\frac{1}{4}$ inch of water. The pressure at which the gas reaches the tap is, however, usually far greater than $\frac{1}{2}$ inch. Thus during the evening hours in London, up to about twelve p.m., there is commonly a pressure of 3 inches on the upper floors; and even during the very early hours of the morning, when the gas consumption reaches its minimum, the pressure is still fully 2 inches, to judge by observations made at the Home Office and elsewhere. The high pressure appears to be necessary to meet the case of houses or other buildings in which the pipes are of inadequate diameter to supply all the gas-jets. In other towns besides London the pressure may be either lower or higher.

The Nos. 4 to 6 burners in common use pass about 4 to 6 cubic feet of gas per hour when the flow is checked by the tap so as to reduce the pressure at the burner to about $\frac{1}{2}$ inch. If the flow is not properly checked by the tap, there is a far larger passage of gas; and in the ordinary use of gas there is great waste from this cause. In order to check the flow of gas, even partially, the tap usually requires to be turned to a very considerable extent, as the opening of the tap is far larger than the openings of the burner. On examining various ordinary taps, I found that about the maximum outflow of gas was given through angles of about 60° to 90° out of the 180° through which the taps turned between the two stops. It will thus be seen that, in the event of the tap being accidentally turned on, the chances are very considerable that the maximum outflow of gas will occur. In the case of some of the accidents from gas escapes in bedrooms, the gas has been said to be "turned half off;" but it is evident, from what has just been mentioned, that in such cases the maximum outflow may nevertheless have occurred.

Table 3 shows the rates of outflow observed with a set of ordinary Bray's "enamel regulator" burners; the pressure being 1·7 inches (about the usual pressure in Oxford after 11 p.m.). The flow was measured with an accurately graduated wet meter of sufficient size; and the pressure-gauge was between the meter and burner. The gas was not lighted. Table 4 shows the variations in the outflow from a No. 4 ("4-foot") burner with different pressures.

TABLE 3.

Number of Burner.	Rate of Escape per Hour in Cubic Feet.
1	5·5
2	6·1
3	7·5
4	8·2
5	9·5
6	11·0
7	11·8
8	14·8

TABLE 4.

Pressure in Inches of Water.	Rate of Escape per Hour in Cubic Feet.
0·5	4·4
1·0	6·3
1·5	7·7
2·0	8·9
2·5	9·8
3·0	10·9

It will be seen from Table 4 that, at the lowest London night pressure observed at the Home Office, a "4-foot" burner passes about 9 feet with the flow unchecked by the tap, and the gas unlit. The Oxford gas, with which the measurements first described were made, had a specific gravity of 0·44 and a candle power of about 17 at the gas-works. Carburetted water gas of high candle power has a specific gravity of about ·60 to ·65; and this higher specific gravity would affect the flow. As this varies inversely as the square root of the specific gravities, the flow of carburetted water gas would be about an eighth less than that of coal gas, with the same pressure.

Experiments on the Escape of Gas in Ordinary Rooms.

The plan of most of the experiments was simply to allow gas to escape at known rates from the burners in a number of different rooms, and to determine the percentages of gas which gradually accumulated at different points in the air of the room. From the results, it could be seen how the gas distributed itself in the room, how rapidly it was carried off by ventilation, and what the danger to a person sleeping in the room would have been with various kinds of gas, differing from one another as regards their percentage of carbonic oxide. In a further series of experiments carbonic acid from lighted candles was allowed to pass into the air at a known rate; the object of this series being simply to determine the rates at which natural ventilation of an ordinary room proceeds under varying conditions, as regards weather, ventilation by fireplace, window, &c. As regards this important subject existing knowledge is extremely scanty. The experiments with the escaping gas were, all but one, made at the

* This is only a rough estimate. It must be remembered that an accurate determination of carbonic oxide in coal gas or water gas by the methods ordinarily used requires great care, and that many published analyses are probably very inaccurate.

Physiological Laboratory, Oxford; those with candles in two rooms in my own house.

Description of Rooms Used.

Room A, in which most of the experiments with gas were done, was selected as being of a common size for bedrooms. It has a capacity of 1124 cubic feet, and is 11½ feet long by 8½ feet broad by 11½ feet high. There is one window of ordinary size, and one wall is an outside one of sandstone. Of the other walls one is of sandstone; and the other two of wood and plaster, 7 inches thick. The walls are not papered, and there is no fireplace. The room is on the ground floor of the laboratory, and has one floor above it, and a basement below. The gas-jet is at a height of 6 ft. 3 in.

Room B, on the first floor, has a capacity of about 900 cubic feet. It is 14 ft. 4 in. long, 7 ft. broad, 9 ft. high, and has three windows and a fireplace. All the walls are of sandstone; and half the wall space is outside wall. The room is not papered. The gas-jet is at 6 feet.

Room C, in which a short experiment with gas and a number of experiments with candles were made, is in my own house, and has a capacity of 1390 feet. It measures 11½ ft. by 13 ft., and is 3 ft. high. There is one window, and a fireplace. One wall is an outside one, of brick. The walls and ceiling are papered. There is no gas in the room, and gas was therefore brought through indiarubber tubing from a gas-jet in a neighbouring room, and allowed to escape at the floor-level.

Room D, on the ground floor, has a capacity of 5840 feet, and is 24¾ ft. long, 19½ ft. wide by 11½ ft. high. Two walls, the outside one and one inside, are of sandstone; one is of brick, and the other wood and plaster, about 7 inches thick. There are two large double windows, and no fireplace. The room is not papered. The gas-jet is at 7 feet.

Room E, on the first floor, has a capacity of 3094 feet. It has no outside wall, and is used as a store-room. It has two doors and two windows, looking into other rooms. It is 24¾ ft. long by 19½ ft. wide, and 11½ ft. high. The two end walls are of sandstone; and the side walls of wood and plaster. It is divided into two parts by a glass partition 8 feet high.

Room F, on the basement, has a capacity of about 1030 feet, and is 17½ ft. long by about 6 ft. broad, and 7 ft. 8 in. high. The walls are of sandstone, except for one end wall, of brick; and nearly half the wall space is outside wall. The roof is arched with brick, and supports the concrete floor of the gas-analysis room, which is immediately above, and in which no smell of gas was perceptible during the experiment. There are two doors and no fireplace.

Room G, also in my own house, is an attic room of very irregular shape, and of 786 feet capacity. It has one window, and no fireplace; and the walls, but not the ceiling, are papered.

Method of Examining the Air for Gas.

To obtain a rough idea of the amount and distribution in the room of the gas present in the air, I used the flame-cap method employed by miners for detecting fire-damp. This method, which is a good deal more sensitive than is commonly supposed, depends on the fact that, when more than a very small proportion of any inflammable gas is present in the air, a conical "cap" of very slightly luminous flame appears on the top of the ordinary flame. To see the cap, the wick must be pulled down until only a small blue flame is left. If less than 1 per cent. of coal gas is present, the cap on an oil-flame is very pale, and is not visible until the eye has become accommodated to the dim light. With less than 0·5 per cent. no cap at all can be seen on an oil flame; but with the hydrogen flame of a Clowes safety lamp, a distinct cap can still be seen with as little as 0·1 per cent. Unfortunately the height of the cap does not, with about 1 per cent. of gas and under, vary in proportion to the percentage of gas present. With practice, however, it is still possible to form a rough idea, from the luminosity of the cap, of how much gas is actually present; and I found the method of testing the air with a safety-lamp of much use as an auxiliary method in tracing the distribution of the gas in a room. The lamps used were an ordinary bonneted Clanny, with paraffin oil, and a Clowes hydrogen lamp. The Oxford gas fortunately contains only about 7 per cent. of carbonic oxide;* so that, even when the air was explosive, there was for a few minutes no risk of becoming giddy on the ladder used in examining the air at the roof.

To determine, as nearly as possible, the exact amount of gas present, samples of the air were collected in small bottles provided with tightly-fitting paraffined corks, and at once analyzed in another room. About 20 c.c. of this air were accurately measured to ·001 c.c. after the traces of carbonic acid present had been removed. The air was then passed over a Coquillion's spiral of platinum wire heated electrically to a white heat, so as to burn completely the gas present in the air. The diminution of volume in the air, and the volume of carbonic acid formed, were then successively determined; and from these data the percentage of gas present was calculated. The apparatus used was that which is described in the *Journal of Physiology*, Vol. 22, p. 475, 1898, where it is shown that the method is accurate to ·005 per cent. The Oxford coal gas was found to give a contraction of 1·54 volumes and to form 0·535 volume of carbonic acid for every volume of gas burnt. The following are the figures obtained in three analyses made on different days, while the experiments were in progress:—

—	1.	2.	3.	Mean.
Volume of gas taken .	1·96 c.c.	1·72 c.c.	1·555 c.c.	..
Contraction on combustion with air . .	3·05	2·635	2·24	..
Volume of CO_2 formed	1·07	0·92	0·76	..
Volume of oxygen consumed	2·26	1·93	..	..
Volume of nitrogen in coal gas	0·10	0·10	..	..
Ratio of contraction on combustion to gas taken	1·55	1·52	1·54	1·54
Ratio of gas taken to CO_2 formed . . .	1·83	1·88	1·92	1·87
Ratio of contraction on combustion to CO_2 formed . . .	2·85	2·88	2·95	2·89

* Determination made by the blood method gave 7·2 per cent.

At first sight it might seem that to obtain the volume of coal gas in the sample of air under examination, it would only be necessary to divide the observed contraction on combustion by 1·54, or to multiply the volume of carbonic acid formed by 1·87. It was soon noticed, however, that these two methods of calculation usually gave different results. At first I suspected that something was wrong in the analyses; but a repetition of an analysis always gave exactly the same result as before. It thus became clear that the coal gas mixed with the air in the room not only differed in composition from the original coal gas, but also differed considerably at different parts of the room. Thus, to take an example, in experiment No. 7 the ratio of contraction on combustion to carbonic acid formed was 1 to 5·9 in a sample taken at 5.30 p.m. from a height of 4 feet, and 1 to 2·35 in the sample from the roof, as against 1 to 2·88 in the original coal gas of the same evening. In this experiment most of the escaping gas remained at the roof. Evidently the hydrogen, which is by far the most diffusible constituent of coal gas, was diffusing away in all directions, including downwards towards the floor, more rapidly than the other constituents. Consequently the gas mixed with the air in the roof was poorer in hydrogen than the original coal gas, and thus gave a smaller contraction per volume of carbonic acid formed; while the gas mixed with the air near the floor was almost pure hydrogen, and thus gave a relatively very large contraction per volume of carbonic acid formed. The fact that hydrogen, which is the lightest constituent of coal gas, should be, relatively to the heavier constituents, far more abundant near the floor, seems at first sight somewhat paradoxical, but is in reality exactly what might have been predicted.

In view of the facts just stated, it is clear that the percentage of coal gas estimated as being present in a sample of air will differ appreciably according as the contraction on combustion or the volume of carbonic acid formed is used as a basis of calculation. For the practical purposes of the present investigation, however, it seems clear that the percentage ought to be calculated from the volume of carbonic acid formed. Since hydrogen is by far the most diffusible of the constituents of coal gas, the change in composition of the gas will, practically speaking, depend on loss of hydrogen, and not of any of the carbon-containing constituents of the gas. Among the latter is carbonic oxide, the poisonous constituent of coal gas. Hence the carbonic acid formed on combustion will be the best measure of the poisonous action of the gas; and in Table 5 the percentages of coal gas present in the air are calculated by multiplying the percentage of carbonic acid formed on combustion by 1·87.*

The Distribution of Escaping Gas in the Air of a Room.

One of the most striking points in Table 5 is the great diversity in different experiments as regards the amount of gas present after a given interval of time at a height of 4 feet. Most of the samples were collected at this height, since the head of a person sleeping in bed would be about 4 feet from the floor. In experiment No. 7, for instance, only 0·082 per cent. of gas was present at this level after 6½ hours' escape; whereas in experiment 11, with the same burner and same pressure of gas, 0·93, or eleven times as much, was present at the same level after one hour's escape. The reason why in some of the experiments so little gas was present at the 4 feet level was not at first apparent. Some of the experiments were made by day, because I thought that since by day there was less difference of temperature between the inside and outside of the building, the maximum amount of gas capable of accumulating in the air of a room could best be ascertained by day. Pettenkofer has shown experimentally that, other things being equal, the ventilation of a room through the walls depends on the difference of temperature between the air inside and outside of the room; and it is very probable that with escapes during the daytime more gas would, on the whole, remain in the room with a given rate of escape. The experiments show distinctly, however, that at 4 feet from the floor there was during the day (with inside and outside temperature nearly equal) much less gas in the air at a height of 4 feet from the ground than during the night, when the temperature is considerably lower outside than inside. The explanation seems perfectly clear. During the night the windows are cooled by the cold air outside, and consequently downward currents of cold air, which could easily be observed with the help of chloride of ammonium smoke, are established at the windows. The air of the room is in this way completely mixed; so that the amount of gas in the air is the same at the floor and at the roof. When these convection currents are absent, the coal gas remains mostly at the roof; there being nothing to bring it downwards except diffusion, the influence of which is comparatively feeble in an air-space of the size of a room. Diffusion will, moreover, be largely counteracted by a slow general upward current in the air of the room, due to the diminished specific gravity of the air, which will cause it to escape at the roof. In experiment 11, which was purposely not begun until ten p.m., when the temperature outside was 7° C. lower than that inside, the mixture of the air was complete from the beginning; whereas in all the experiments begun during the day, there was until night much more gas in the air above than below. In experiments Nos. 4, 5, 6, and 15 the difference which existed during the day between the air at the roof and at 4 feet disappeared as the night advanced. In experiment 15, which was made in a room with no external windows, there was still during the night four times as much gas at the roof as at 4 feet. Experiments 9 and 12, in which the burner was removed, so as to produce a very great escape of gas, show that, with such a large escape, there is less tendency for the air above and below to mix. The air above became explosive, and in experiment 9 continued during the whole experiment to contain about ten times as much gas as the air below, in which there was actually no more carbonic oxide than is often present in the air of Gower Street or Portland Road Stations. The attempt made in this experiment to produce a poisonous atmosphere near the floor-level with the Oxford coal gas was thus wholly unsuccessful. The air at the roof had rapidly become so much lighter than the air below, that convection currents down the windows were practically abolished, in spite of the fact that the outside air was about 3° C. colder than that inside the room. In experiment 12 the same attempt was repeated, with a temperature difference of 11° C.; but although there was a greater tendency towards mixture, the air at the 4-feet level was still not poisonous, and would not have been so unless 10 per cent. or more of carbonic oxide had been present in the gas escaping. In room E, which has no outside walls or windows, several

* Table 9, which we give, shows the practical conclusions drawn by Dr. Haldane from his experiments.

attempts to get the gas to mix with the air below were unsuccessful, even during the night.

The evidence obtained from the analyses that diffusion of hydrogen occurs downwards from the roof, has already been referred to above. That diffusion of hydrogen outwards through the walls and roof also takes place is evident from the fact that, on the whole, the ratio between the contraction of the air on combustion and the carbonic acid formed, is diminished in the air of the room as compared to the ratio with pure coal gas. This is distinctly seen in experiments where the air of the room finally became thoroughly mixed (Nos. 4, 5, 6, 11, 16). In the experiment in room E (No. 18), as might have been expected, the fall in the ratio was very considerable. The most extreme fall was, however, observed in experiment 12, at the end of which, after the gas had been turned off, the room was left shut up for eleven hours. When I went in again, there was still a smell of stale gas, and a very careful analysis (which was repeated three times, so as to exclude as far as possible experimental error) showed that the very small amount of gas still present in the room gave a ratio of contraction to carbonic acid formed of 0·45 to 1. The gas left in the room must thus have lost practically all its hydrogen and methane, and was probably made up of a mixture of carbonic oxide, ethylene, benzene vapour, &c. This mixture would doubtless be far more poisonous, in proportion, than the original coal gas. The possible influence of diffusion in increasing or diminishing the poisonous action of a given percentage of coal gas must be specially borne in mind in cases of escape from leaky mains or service pipes, as well as in ordinary escapes from burners. In the case of pure water gas (uncarburetted), the influence of diffusion on both the specific gravity and the poisonous action of the gas might be very rapid.

As under ordinary conditions of gas escape from burners, hydrogen was passing outwards by diffusion, the other constituents of the gas were certainly doing so also, though much more slowly. The more rapid diffusion outwards of hydrogen would very appreciably increase the specific gravity of the gas left in the air, and so diminish the tendency of the air in the room to flow outwards through the roof and upper part of the walls. Judging by the ratio of contraction on combustion to carbonic acid formed, the gas present in the air of the room had, after a short time, usually lost about 15 per cent. of hydrogen, or about a third of the quantity present in the original gas. This would probably increase the specific gravity of the gas present in the air from ·5 to nearly ·7. In several cases the gas in the air near the floor contained, after some time, proportionately less hydrogen than at the roof. In consequence of this, and of the fact that the percentage of gas present was calculated from the carbon, the amount of gas at the floor appears in the table to be somewhat greater below in one or two instances.

The occurrence, during the sittings of the Committee, of a somewhat remarkable case of poisoning by gas at Preston (which is supplied with a mixture of coal gas and water gas) led me to make one or two further experiments on the conditions determining the mixture of gas with the air of a room. In the case referred to, two men who were sleeping in a small room in a public-house at Preston were found in the morning by the landlord with the gas escaping from a burner. One of them answered his questions, and did not appear to be affected by the gas, and said he did not know that it was escaping. The other was asleep at the time, but had afterwards got up. The landlord turned off the gas, opened the window for a short time, and then left the men. In the afternoon both were found dead. The circumstances seemed to suggest that possibly there was a large percentage of gas in the upper part of the room when the landlord came in, and that the gas afterwards came down from the roof and overcame the men. Though this supposition is not really necessary to explain the circumstances, an experiment was made in room A to test its possibility. Gas was allowed to escape for three-and-a-half hours (from 7.10 to 10.40 p.m.) from a No. 6 burner. At the end of this time, there was only 0·255 per cent. of gas (calculated from the carbonic acid formed) at 4 feet from the floor; while there was 3·37 per cent., or thirteen times as much, near the roof. The ratio $\frac{\text{contraction}}{CO_2 \text{ formed}}$ was 5·1 at 4 feet, and 2·35 at the roof, so that the gas at 4 feet was chiefly hydrogen, while that at the roof contained less hydrogen than ordinary coal gas. The temperature was 2° C. higher in the room than outside. The gas was turned off when the sample was taken, and the room was left closed. At the end of an hour and a half, a sample taken at 4 feet contained 0·93 per cent., and at the roof 0·93 per cent.; the temperature being now 4·5° higher inside than outside. The ratio $\frac{\text{contraction}}{CO_2 \text{ formed}}$ was 2·45 at 4 feet, and 2·6 at the roof. Thus the gas from the roof had descended; so that the air at the 4-feet level actually contained about four times as much carbonic oxide as it did when the gas was turned off. Had the gas escaping consisted largely of water gas, it is evident that a person sleeping in the room might easily have been poisoned after the gas was turned off, although he had not been sensibly affected while it was escaping. A further pair of samples taken an hour later than the last-named gave 0·74 per cent. at the roof and 0·79 per cent. at 4 feet; the ratio $\frac{\text{contraction}}{CO_2 \text{ formed}}$ having further fallen to 2·3 at 4 feet and 2·4 at the roof.

A second experiment of a somewhat similar kind gave a very different result. Gas was allowed to escape for fifty minutes from two jets, from one of which the burner had been removed. Samples were then taken, the gas turned off, and the room left closed. At 4 feet there was only 0·025 per cent. of gas; and the smell was hardly perceptible. At the roof there was 6·92 per cent. of gas, or 276 times as much. One and three-quarter hours later there was 0·102 per cent. of gas at 4 feet, and 0·116 per cent. at the roof; the ratio $\frac{\text{contraction}}{CO^2 \text{ formed}}$ being 3 at 4 feet and 4 at the roof. In this experiment, therefore, the large amount of gas first present in the roof had evidently passed out above, without descending to the floor, and had left behind it little else but a small portion of its hydrogen. The temperature differences between the inside of the room and the outside air were about the same as in the previous experiment.

These two experiments show clearly how uncertain is the final result when gas collects in the upper part of a room. The more rapid diffusion of hydrogen downwards and outwards will tend (1) to make the air below lighter, and (2) to make the air above heavier. This will favour the formation of convection currents; and thus tend to bring the gas down from the roof. When, however, the proportion of gas above is very large, convection currents cannot be formed in this way until most of the gas has left the room through the ceiling and upper part of the walls. A moderate escape of gas from an ordinary bracket would thus seem to be almost more dangerous to a person sleeping than a great escape; and it is evidently unsafe to remain in a room where gas has been escaping until all parts of the room have been thoroughly ventilated.

Experiments with Candles burning in Rooms.

Table 6 which follows gives the results of the experiments in which candles were allowed to burn in the room. The amount of carbonic acid formed per gramme of candle burnt was first accurately determined, and found to be 3·05, corresponding at the temperature of the room to 1·64 litres or 0·058 cubic feet. Three weighed candles were placed at about 2 feet from the floor at different parts of the room, allowed to burn for a known time, and weighed again at the end of this time. The rate at which carbonic acid was passing in the air during the experiment was thus known. Samples of the air from a height of 4 feet and from the roof were taken in small bottles at intervals, and analyzed during the experiments in the gas analysis apparatus previously referred to. After a sufficient interval the composition of the air of the room became more or less constant; and it was then possible to calculate the rate at which the air of the room was being renewed by ventilation, after allowance for the small quantity of carbonic acid (0·03 per cent.) known to be present in the outside air and in the air of the passages, &c., in other parts of the house.

The Rate of Exchange of Air in Rooms.

It is, of course, quite evident that the rate at which the air of a room is changed by natural ventilation processes must vary greatly according to circumstances. It is nevertheless of great importance to obtain a rough conception of what the rate of change is likely to be under the conditions commonly met with in bedrooms; and the results of the experiments given, and of several previous ones made about forty years ago by Pettenkofer, render it possible to frame such a conception.

We may take first the very common case of a room with closed window and door, and no fire-place, or with the opening of the fire-place closed by a flap. Pettenkofer was the first to show by definite quantitative experiments that, even in such a room, there is in practice always a very considerable exchange of air going on. The room in which he made his experiments had a capacity of about 3000 cubic feet; and he found in four experiments that the time required for the air of the room to change, or, more correctly, for a volume of air to enter equal to that of the capacity of the room, varied from 1 to 3·4 hours. Thus, supposing gas to be escaping continuously in this room at the rate of 10 cubic feet per hour, and the gas to be mixing itself completely with the air of the room, the percentage of gas finally reached in the air would vary between 0·33 per cent. under the most favourable conditions of ventilation, and 1·13 per cent. under the least favourable conditions. Under the most favourable conditions, there existed the very great difference of temperature of 21° C. (38° Fahr.) between the air inside and outside, and under the least favourable conditions there was a difference of only 4° C. (7° Fahr.); and Pettenkofer lays great stress on temperature difference as a cause of exchange of air. He further showed that the exchange of air is chiefly through the walls, and that the exchange of air was only diminished by 28 per cent. when all the chinks and cracks were carefully stopped up, and only increased to double when 8 square feet of window were opened, with a small temperature difference.

In my experiments, temperature differences seem to have had an effect much less marked than might have been expected from Pettenkofer's experiments, except on nights when the whole of the laboratory was heated up by the hot pipes (Experiments 11 and 17). It seems probable that the effect of temperature on the ventilation of a room depends chiefly or largely on the influence of the building as a whole. During the night or in winter, when the temperature of a house is above that of the outside air, the pressure in the house is usually negative on the lower floors, and positive above, so that there is a draught of air inwards through the walls, and down the cold chimneys of the lower rooms; while in the upper rooms the draught is outwards through the walls and up the chimneys. In the intermediate rooms there is little draught due to temperature differences; and as rooms A, D, and G, in which most of the experiments were made, had a more or less intermediate position, it was hardly to be expected that they would show very great differences of ventilation with varying temperature differences. The influence of wind in promoting natural ventilation of a closed room is shown very distinctly in the experiments with burning candles; as on a windy day the ventilation was nearly double that on a still day.

The ventilation of a room with gas escaping in it must be to some extent favoured by the presence of the gas itself; but this influence is only slight unless the percentage of gas is high. Moreover, the gas as shown above increases in specific gravity from loss of hydrogen by diffusion; and carburetted water gas has, even when not affected in composition by diffusion, a specific gravity much nearer that of air than coal gas.

Rooms A and G were chosen for most of the experiments, with special reference to the fact that while they were of nearly the same size and shape, their walls were of very different materials, and that both the walls and ceiling of G were papered, whereas C was unpapered. The results obtained as regards rate of natural ventilation in these two rooms were nevertheless very much the same under similar circumstances. In Room A the slowest rate of change is in experiment 6, where, with a rate of gas escape of 11·6 feet per hour, there was finally about 2·65 per cent. of gas at all points in the room. As the capacity of the room is 1124 feet, the air was only being changed once in 2·3 hours. The most rapid rate of change is in experiment 11, made while the building was heated up by hot-water pipes. With a gas escape of 11·8 feet per hour the final percentage of gas was 1·25; so that the air was being changed once in 1·2 hours. In Room C with all openings closed, the slowest rate of change was once in 2·5 hours; and the most rapid once in 1·3 hours, on a windy day. In Room D the least rapid rate of exchange of air observed under unfavourable conditions was once in 3·6 hours. This result differs considerably from those obtained in A and C, and resembles Pettenkofer's result of once in 3·4 hours in his room of 3000 (English) cubic feet. A little consideration shows, however, that, other things being equal, the

rate of change of air in a room must depend on the extent of the surface (walls, roof, and floor) through which air can pass. And as in rooms of similar form the surfaces increase as the square, and the capacity as the cube, of any corresponding diameter, the proportion of surface to capacity must continually diminish with increase in size of the room. Consequently, it is only what might be expected that in Room D and in Pettenkofer's room the rate of exchange of air would be less than in Rooms A and C. If, however, allowance be made for the increased size of the former rooms it will be found that the minimum rate of permeation of air through the walls, &c., was nearly the same in all the rooms. If we assume that with a nearly cubical room of 1000 cubic feet capacity, the minimum rate of change of air is once in 2·3 hours, then Room A would give once in 2·4 hours, Room C once in 2·5 hours, Room D once in 3·9 hours, and Pettenkofer's room once in 3·3 hours. The actual results correspond with great closeness to this calculation. We may therefore assume with great probability that, except under very exceptional circumstances, the air of a closed room of 1000 cubic feet capacity will be changed at least once in 2·3 hours.

It is, of course, easy to imagine that, with a state of absolute stagnation of the outside air, and absolute equality of temperature between inside and outside, no ventilation at all would take place except what might be due to diffusion. For the purposes of the present investigation, however, this possibility may be disregarded, because were such a state of matters to exist, an escape of gas to any dangerous extent would at once disturb the supposed state of equilibrium. Moreover, unless the outside temperature were some degrees lower, the gas (as shown above) would remain at the roof, and cause no danger to a person sleeping in the room.

As many bedrooms have a capacity less than 1000 cubic feet, it is of importance to calculate the rate of exchange of air in them also on the basis arrived at above. Table 7 contains the results of such a calculation for rooms of different sizes. With a capacity of 500 cubic feet, the maximum time required for a volume of air equal to that of the room to enter the completely closed room was 1·8 hours; 750, 2·1; 1000, 2·3; 1500, 2·65; 2000, 2·9; 3000, 3·3; 4000, 3·6.

In most bedrooms of over 1000 cubic feet capacity there is, in this country, at least, an open fire-place; and, as a general rule, the flap or other means of closing the fire-place is kept unclosed. In my experiments, the effect of the open fire-place in promoting ventilation is very clearly shown; and, as a general rule, the open fire-place about doubled the ventilation of Room C. In this room, which is on the middle floor of the house, there seems always to be an air current up the chimney. The values given for the draught up the chimney were obtained approximately by means of a sensitive anemometer, on the usual assumption that the effective opening is about two-thirds of the actual opening in which the air-current was measured. On observing the chimney draughts in other rooms in the house, it was found that, on the ground floor particularly, the chimney draught, with no fire burning, was very variable. Thus, in the dining-room, with the door open, there was on one evening a down draught of about 2700 cubic feet per hour with the door open, and no perceptible draught at all with the door shut. Chimney ventilation is thus somewhat uncertain in its action, although on upper floors at least it can probably be relied on as a general rule. Another experiment gives the results with a fire burning. It is interesting to compare the result with that of one of Pettenkofer's experiments, during which he had a German stove lighted. The stove gave only about half the air-current of the small open fire-place. With an open fire burning, there would evidently be no chance of serious results from an escape of carburetted water gas from a burner.

Further light is thrown on the subject by the average results of analyses of the air of sleeping-rooms. A systematic series of such analyses was made some years ago in Dundee by the late Professor Carnelley, Dr. Anderson, and myself. The analyses were made in winter, samples of air being collected at about the middle of the night (twelve p.m. to four a.m.) from sixty sleeping-rooms in different classes of houses. The doors and windows were found closed in all cases but one. From the percentage of carbonic acid found in the air, it is possible to calculate roughly the rate of exchange of air in the rooms; and I have constructed the following table in this way. An adult at rest gives off about 0·4 cubic foot of carbonic acid per hour. As, however, a considerable proportion of the persons present in the rooms were children, 0·3 cubic foot per hour has been taken as a basis for calculation in the case of one and two-roomed dwellings.

		One-Roomed Dwellings.	Two-Roomed Dwellings.	Dwellings of Four Rooms and upwards.
In excess of outside air	Temp. Fahr.	19°	18°	14°
	P.c. of CO_2	0·066	0·055	0·033
Cubic feet per person		212	249	1833
Persons per room		6·6	3·4	1·3
Cubic feet per room		1399	846	2382
Time required in hours for whole of air of room to be changed		0·47	0·46	1·5
Number of rooms examined		29	13	18

It is evident from this table that the rate of exchange of air was far greater in the lowest class of dwellings than in the better class. This is probably to be accounted for largely by the fact that the remains of fires were usually present in the fire-places in the lowest class of dwellings, but not in the better class, although fire-places were always present in the rooms examined. When allowance is made for the large size of the rooms examined in the better class of houses, it will be found that the average rate of ventilation found corresponds, for a room of 1000 cubic feet capacity, to a rate of change of 1·15 times per hour. This is a little slower than in Room C, with fire-place open, but twice as fast as with fire-place closed. For the one and two roomed houses, the results correspond closely to those in Room C, with fire burning low. Looking at all the data, it is surprising how concordant they are, when due allowance is made for the varying conditions as regards fire-places, and particularly for the fact, which is evidently a fundamental one in connection with the theory of ventilation of buildings, that the means of natural ventilation do not increase proportionately to increased cubic capacity of rooms.

One of the experiments shows the effect on the ventilation of opening a window. The effect of an open window is, however, evidently very uncertain, particularly when a blind is at the same time pulled down, as is usually the case. In the Massachusetts Commissioners' report for 1897, three cases are mentioned of persons found dead with windows open or broken, and a gas-jet turned on, out of a total of thirty-two fatal accidents from single gas-jets. Three cases are also mentioned of persons found unconscious under similar circumstances.

Practical Conclusions from the Experiments.

In order to throw the results of the experiments into a form as convenient as possible for practical purposes, I have drawn up the following table, showing the percentages of carbonic oxide likely to accumulate in the air of rooms of different sizes, under unfavourable conditions of ventilation (all openings closed, no wind, and no very great temperature difference). The percentages which may be regarded as more or less dangerous are printed in italics, and those which would probably cause death in thick type. The sizes of burners assigned to the different sizes of rooms are as high as are at all commonly to be found, according to my own observations at least. The rate of flow of gas is calculated for average English coal gas at about two inches pressure. For ordinary Scotch gas of high illuminating power, or for carburetted water gas at the same pressure, the flow would be different in inverse proportion to the square root of the specific gravity, as already mentioned. From the table, after due corrections have been made for pressure and specific gravity, it is possible to form a rough practical idea of the possibilities of fatal accidents in different sizes of rooms provided with the ordinary gas-fittings, according to the percentage of carbonic oxide in the gas.

Table 9.

Size of Room in Cubic Feet.	Outflow of Gas in Cubic Feet.	Size of Bray's Burner.	Final Percentage of Carbonic Oxide in Air with escaping Gas containing					
			5 p.c.	10 p.c.	15 p.c.	20 p.c.	25 p.c.	30 p.c.
500	9·1	4	·16	*·33*	**·49**	**·66**	**·82**	**·98**
750	9·1	4	·13	*·25*	*·38*	**·51**	**·76**	**·89**
1000	10·6	5	·12	*·24*	*·36*	**·48**	**·60**	**·72**
1500	12·3	6	·11	*·22*	*·33*	**·44**	**·55**	**·66**
2000	13·2	7	·09	·19	*·28*	*·38*	**·47**	**·58**
3000	13·2	7	·07	·14	*·21*	*·28*	*·35*	**·42**
4000	13·2	7	·06	·12	·18	*·24*	*·30*	*·35*

On comparing this table with the actual statistics of poisoning by coal gas and water gas, the reason for the enormous increase of fatal cases with the latter gas becomes perfectly evident. It is clear that, with coal gas of ordinary composition, it is almost impossible to produce a poisonous atmosphere in a room by simply leaving the gas turned on during the night; whereas with water gas a poisonous atmosphere is easily produced, even in very large rooms.

The above table is calculated not for *average*, but for *unfavourable* conditions of ventilation. In rooms with an open fire-place, the average ventilation would be nearly double that existing under unfavourable conditions. This, however, would not apply to the many small rooms not supplied with a fire-place; and it is towards these rooms that measures of precaution in connection with the distribution of water gas should more specially be directed. There is not the slightest doubt that uncarburetted water gas, even if it were odorized to the same extent as coal gas, would, if distributed under the same conditions as coal gas is distributed at present, cause a far greater number of accidents even than carburetted water gas. In bedrooms of fair size and average ventilation, most persons who left the gas turned on would escape with carburetted water gas, whereas probably most would die with uncarburetted water gas, which contains nearly 50 per cent. of carbonic oxide.

The table renders it possible to reach fairly clear practical conclusions as to the probable degree of effectiveness of various measures which might be taken to obviate the very serious dangers which, if the matter be simply neglected, as hitherto in the United States, undoubtedly attend the use of carburetted water gas.

1. It should be clearly pointed out that dilution of carburetted water gas with coal gas reduces greatly the danger of its distribution. The danger incurred in distributing without special precaution a mixture of one-third water gas with coal gas is not a third, but only about a tenth of that incurred in distributing pure carburetted water gas. This follows from the fact that the accidents from water gas, as compared with those from coal gas, increase about in proportion to the cube of the relative increase in the proportion of carbonic oxide.

2. The dangers arising from a moderate increase in the percentage of carbonic oxide are evidently confined chiefly to the case of small bedrooms without fire-places. Hence most of the danger could be obviated by simply cutting off the gas supply to such rooms. Nearly all the fatal accidents in this country from burners left turned on seem to occur in small rooms without fire-places, particularly attic rooms used by servants and small bedrooms in hotels and lodging-houses. The inconvenience caused by the absence of gas in such rooms would not be great.

3. The dangers in all bedrooms would be enormously diminished by the use of burners so constructed that they would not, at the night pressure, pass more than the quantity of gas required to give a good and sufficient light. The outflow through an ordinary burner with the tap turned full on is fully 100 per cent. in excess of what is needed to give the full light which the burner is constructed to give; and there is thus great waste, as well as increased risk of poisoning. The waste arises from the fact that the gas issuing at too high a pressure from a burner becomes unduly mixed with air; and the flame thus becomes more and more non-luminous the higher the pressure rises. This waste can be obviated either by checking the flow at the tap, or or else by using burners provided with some arrangement for automatically checking the flow before the gas reaches the point of issue. The most perfect means of automatically checking the flow is a governor burner. These burners are so constructed as to give only the proper amount of gas, however high the pressure may rise in the mains. On testing the governor burners made by several well-known firms I found that they gave almost exactly the specified amount of gas, whatever the pressure in the mains might be. A No. 4, for instance, with the tap full on, gives almost exactly 4 feet per hour, instead of from 8 feet to 12 feet as with an ordinary No. 4 burner under the same conditions. These

burners may, however, get out of order after some time, and require to be cleaned; and they cost about 1s. 6d. each. A much less expensive means of checking the flow is to make the gas pass through a narrow opening before it reaches the burner. In practice this is frequently carried out by first fixing a very small-sized ordinary burner, and then placing on the top of it another special burner, with an opening of the proper size for burning to the best advantage the stream of gas which, at ordinary pressures, passes the opening of the first burner with the tap turned full on. This is the principle of several forms of burner sold by Messrs. Bray, and now very extensively used. If the first opening be made of such a size that it will not pass more than a certain specified amount of gas at the ordinary night pressure, this arrangement meets the object of preventing more than a certain definite escape during the night. A comparison of the following table (No. 10) with the immediately preceding one will at once show how very great the difference as regards risk to life would be if such a system of regulated maximum escape were adopted. Practically speaking, gas containing 25 per cent. of carbonic oxide would be as safe, so far as accidental escapes from burners are concerned, as coal gas containing 10 per cent. of carbonic oxide.

TABLE 10.

Size of Room in Cubic Feet.	Outflow in Cubic Feet of Coal Gas at Two Inches Pressure.	Size of Burner.	Final Percentage of CO in Air of Room with escaping Gas containing					
			5 p.c.	10 p.c.	15 p.c.	20 p.c.	25 p.c.	30 p.c.
500	4	4	·07	·14	*·22*	*·27*	*·33*	*·38*
750	4	4	·05	·11	·16	*·21*	*·25*	*·29*
1000	5	5	·06	·11	·17	*·22*	*·26*	*·30*
1500	6	6	·05	·11	·16	*·20*	*·24*	*·28*
2000	7	7	·05	·10	·15	·19	*·23*	*·26*
3000	7	7	·04	·08	·12	·15	·18	*·21*
4000	7	7	·03	·06	·09	·12	·15	·17

4. The dangers may be reduced to some extent by keeping the night pressure in the mains as low as possible, and placing governors on mains supplying high districts; so that there may be no undue pressure anywhere. In some towns the night pressure is doubtless already kept as low as possible; but probably a good deal more could be done in this direction. It should be remembered that, although the reduction brought about in the rate of escape by practicable reduction of pressure may seem small, the danger to life is probably reduced in a much greater proportion. Failing the possibility of a low night pressure in the mains, pressure-governors on the supply-pipe to each house might in some cases be adopted.

5. The dangers might probably be very largely reduced if the smell of the gas were made much more unpleasant than it is; and particularly if some irritating substance were added, the action of which would waken persons who might be asleep, and would be perceptible to persons devoid of the sense of smell. The smell of coal gas or carburetted water gas is very easily perceived by a person coming from fresh air into air containing even small traces of the gas. But it is entirely different for a person in an atmosphere which is being very gradually contaminated by escaping gas; and under such circumstances the smell may be scarcely perceived at all. The ease with which the specific nerves of smell become temporarily paralyzed for any particular smell by previous excitation, is well known; and the same temporary paralysis occurs with coal gas.

As a practical instance of this, I may mention an observation which I recently made in my own house. On coming into the house in the evening, I noticed a distinct smell of escaping gas, although no one in the house noticed it. Finding a gas-tap which was loose, and gave a minute escape of gas, I tightened the screw and soon ceased to notice the smell. On coming in again next day, however, the smell seemed as strong as on the previous night; and suspecting now that there must be some very appreciable escape somewhere, I watched the meter and found that there was an escape amounting to 4·1 cubic feet per hour. After some trouble the real source of escape was found in a sliding pendant in the kitchen; and on applying a light to the place a flame 4½ inches long was obtained. The cook, who had not been out of the house since the previous day, had smelt nothing, although she was constantly in the comparatively small room where the leakage was occurring; and I myself had smelt nothing except when I came in from the fresh air. Another servant said she had noticed the smell when she came into the house from the fresh air, but not either before or since. Such instances might easily be multiplied; and they show the probable utility of making the odour of gas with an increased percentage of carbonic oxide far more pungent and unpleasant.

It may, of course, be pointed out that any such measures as those just discussed will only diminish the dangers, and not do away with them. If, however, the dangers can in practice be confined within what are generally recognized as reasonable limits, this is all that need be aimed at. These limits have undoubtedly been very greatly exceeded in connection with the distribution of carburetted water gas in the United States; and it therefore devolves upon those gas engineers who propose to distribute water gas in this country to propose at the same time such measures in connection with its distribution as will afford a guarantee of reasonable safety. Any inconvenience or expense entailed by such measures must be balanced against the economic or other advantages ensuing from the use of the water gas.

Escapes from Gas-Stoves, &c.

Of the accidental deaths in Massachusetts 9 per cent. were due to escapes from gas stoves or heaters, or from the tubing leading to them. Several of these were due to the turning on of the tap of an unconnected nozzle intended for a gas-stove; but in most cases it is simply stated that the gas was escaping from the jets of the stove. In some cases, at least, the stoves would seem to have had no flues; and one death was apparently due to escaping products of imperfect combustion. The dangers of gas stoves or heaters without proper flues, or connected simply by rubber tubing to a nozzle, are evident, even when the stove or heater is lighted. A Bunsen flame may "strike back" unless this is specially guarded against, and thus give off a very poisonous mixture of gases when only ordinary coal gas is used, or the combustion may be imperfect from undue cooling of the flame or some other cause. It must be remembered that gas stoves and heaters may burn a very large amount of gas. I measured the escape from an ordinary geyser which caused a fatal accident in a bathroom in Oxford in 1897, and found it amounted to 72 feet per hour. Good and intelligent workmanship in connection with the fitting of gas-heating arrangements is certainly very necessary, particularly when water gas is supplied mixed with the coal gas.

Escapes from Broken Main or Service Pipes.

The accidents arising from broken pipes underground, and consequent penetration of gas into houses, require very careful consideration in connection with the introduction of carburetted water gas. With ordinary coal gas containing less than 10 per cent. of carbonic oxide, there is not much danger of serious accidents by poisoning from this cause, though accidents from explosions occasionally occur; but with increase in the percentage of carbonic oxide in the gas the risk of serious accidents, involving possibly the loss of many lives at a time, may become very considerable unless great attention is paid to the laying and maintenance undisturbed and in sound condition of all underground gas pipes in towns. Only 5 per cent. of the fatal accidents from asphyxia recorded in the Massachusetts reports were due to leaking underground pipes; but even this small proportion represents a very great increase—probably about fiftyfold—over the similar accidents in this country with ordinary coal gas. It ought also to be remarked that the mains of the Boston water-gas companies would seem to be extremely well looked after. It is possible to judge roughly of this from the percentage of unaccounted-for gas in the official returns. On an average, for the whole of Great Britain the percentage of unaccounted-for gas—*i.e.*, gas which disappears between the gas-works and the consumers' meters—was 9·2 in 1896. In the case of the Boston companies, it was only 3 per cent. in 1897, although ten years earlier, when the same companies were distributing coal gas, it was 8·5, or nearly three times as much. In London the percentage is about 7; but in many English and Scotch towns it is much higher—the state of the mains and service-pipes varying very considerably in different towns. It will thus be seen that, even at the best, a large quantity of gas must escape under the streets, and a great deal of this can only find its way out through houses.

The mode of occurrence of poisoning from broken or leaky mains has been carefully investigated by Pettenkofer and several of his pupils. It was shown that fatal accidents due to escape of gas from the mains mostly occur in winter, when, in consequence of the considerable difference of temperature between the inside and outside of houses, air from the ground is specially liable to be sucked inwards. The poisoning very frequently occurs in houses where no gas is laid on; and in the cases given, the cause of illness or death was sometimes not at all suspected at first—the gas having lost its characteristic smell during its passage through the earth, and only getting into the houses at night or during cold weather. In the first case recorded by Pettenkofer the illness was diagnosed and treated as typhoid fever, and a nurse and another person living in the house were believed to have been infected by the patient. A slight smell noticed was attributed to drainage and to flowers in the room. The patient most seriously affected was, when pronounced by the doctor to be moribund, saved by a friend, who insisted on his removal to another house, as she detected the smell of gas. Other similar cases are recorded* in one of which death had already been certified by the doctor in attendance (the illness had lasted two days) as due to another cause, when the occurrence of further cases of severe illness among relatives who had come to the funeral† led to an examination for carbonic oxide of the blood of the patients, and a post-mortem examination of the body. The real nature of the illness in the house was thus discovered; and next day a quite distinct smell of gas was detected. Cases of illness and death attributed to "sewer-gas," "blood-poisoning," "cardiac failure," &c., are in all probability sometimes caused by leaky gas-mains. In some cases the gas may get into the houses through the drains, and render sewer air, which is ordinarily quite harmless, not only poisonous, but also explosive from the quantity of gas mixed with it.

Experiments showing definitely that the gas passing through certain kinds of soil loses at first, not only its smell, but also its illuminating constituents, are given by Professors Sedgwick and Nichols in their report on coal gas and water gas, 1885.

In many of the reported cases of accidents from escapes from mains the circumstances certainly seem such as to suggest that no smell, or only a very slight smell, of gas was at first perceived. Some of the Boston non-fatal cases, for instance, occurred by day. Thus two accidents in bakehouses are recorded in the report for 1895. In the first case five bakers "were found upon the floor in various positions" at about four p.m.; and in the second case three were found in the forenoon unconscious in another shop in the same street a few months later. In a case which occurred in Bristol in 1895 ("JOURNAL OF GAS LIGHTING," Feb. 19, 1895), no distinctive odour of gas seems to have been perceived, although so much gas was present that there were two explosions, originating in one case at a fire, and in the other at a lamp. Two persons were fatally poisoned. The main was investigated under the direction of the Manager of the Gas Company, and the true cause of the accident ascertained.

The following extract from the Massachusetts report of 1897 illustrates the alarming character of escapes from mains when water gas is used. It would seem that it was only by a fortunate chance that a most serious disaster was avoided. "On the night on Jan. 15, gas from a leak in a main on East Canton Street, Boston, entered the entire block of buildings on each side of the street, occupied by about one hundred persons. When found, Hattie M'Swain, eighteen months of age, daughter of Alexander M'Swain, of 89, East Canton Street, was dead, three aged women were in a precarious condition, and twenty-one others were partially asphyxiated. The discovery of the leak was made by J. L. Dixon, tenant of 88, East Canton Street, at two a.m. He found his wife and baby unconscious;

* Biefel and Polack ("Zeitschrift f. Biologie," XVI., p. 314) record the fact that in Breslau alone ten cases of poisoning, one of which was fatal, occurred during six weeks of very cold weather. The gas mains in the town had been more than usually interfered with during the previous year in consequence of the construction of new sewers.

† The widow, three sons, and a niece were all found unconscious in the house on the second day after the man's death. They had suffered from giddiness, &c., on the previous day, the same symptoms as the deceased had himself first suffered from.

and two other persons in his house were very much overcome At 89, East Canton Street, Hotel Lawrence, the janitor aroused over forty. persons who were overcome by gas, and at No. 90 many others." In another case mentioned in the same report, the three persons occupying one house were found dead in the morning; while the occupants of the next house were rescued by the police in time to save their lives. In this country the most serious similar case of which I have been able to find any record occurred in Glasgow in June, 1894 ("JOURNAL OF GAS LIGHTING," June 19, 1894). The gas entered a tenement house; and the real source of the leakage—an old supply-pipe of which the existence was unknown—was not discovered for several days. Unfortunately the doors of the houses on the ground floor were not forced when the smell of gas was first noticed; and when, after three days, these houses were entered, the five women occupying them were found to be all dead. Probably there was a good deal of carbonic oxide in the gas, as the coal gas itself in Glasgow contains from 10 to 11 per cent. of carbonic oxide, and water-gas plant was also being used at the time. Another very similar case, attended by two deaths, occurred in Glasgow in 1896 ("JOURNAL OF GAS LIGHTING," September, 1896), with no water gas in use.

Nearly all of the accidents where large volumes of gas penetrate into houses are due to disturbance of gas-pipes by digging operations in connection with water-pipes, drains, sewers, &c., and consequent subsidence of ground. In some cases steam-rollers seem to be the immediate cause of the break. Serious sudden leakages from mains and service-pipes are by no means infrequent. Mr. Eldridge, the Manager of the Oxford Gas-Works, kindly looked up for me the records of such occurrences in Oxford during recent years. The average was thirty to forty a year. As the mains are not very deeply placed, and most of the streets macadamized, probably the number is greater in proportion in Oxford than in many other towns.

The dangers of asphyxia or explosion from breakage of a main depends largely on whether the ground-floors of the neighbouring houses are protected by areas or properly ventilated cellars. Where this is not the case, the gas is easily sucked or driven into the house, and may even come from considerable distances in winter.

It seems very clear that in the case of a town where it is proposed to distribute carburetted water gas, special care ought to be taken that the mains and service-pipes are in a sound state of repair, and not exposed to accidental disturbance, and that they are never laid bare without the ground round them being most carefully filled in again under proper supervision. Where water gas is distributed, the police ought to have strict instructions to report at once any case in which a smell of escaping gas is perceptible in the streets, and to warn the persons in neighbouring houses; also to give special attention to places where the roadway has been recently disturbed.

As lighting gas in passing through the ground may lose its smell, either wholly or partly, and doubts may thus arise as to whether carbonic oxide is present or not in the air of a house in appreciable proportions, it may be worth while to mention that small percentages of this gas may be detected, and, if necessary, accurately determined, with great ease by means of blood solution. Blood, which may be easily obtained from a needle-prick in the finger or ear, by squeezing, or from a slaughter-house, is diluted with water till the solution looks yellow in a test-tube. A small portion of this solution is placed in the bottom of a small clean and dry bottle, which is filled with the suspected air by sucking in a breath through a piece of indiarubber tubing, one end of which is placed in the bottle. The bottle is now corked, wrapped in a cloth in order to exclude light, and thoroughly shaken up for a few minutes; the blood solution is then poured out into a test-tube, and its colour compared with that of the original blood solution, which must be placed in a test-tube of the same width. If any carbonic oxide is present, the characteristic pink tint will be more or less visible, according to the percentage in the air. The percentage may even be roughly estimated by comparing the tint with that of another sample of the same blood fully saturated with carbonic oxide by shaking with coal gas. With 0·07 per cent. of carbonic oxide in the air, the tint is midway between that of the normal and the fully saturated blood; with 0·023 per cent. and 0·21 per cent. the tint is one-fourth and three-fourths towards the tint of full saturation.*

The Products of Combustion of Coal Gas and Carburetted Water Gas.

As regards products of combustion, there would seem to be very little difference between coal gas and carburetted water gas. One volume of the Oxford coal gas, which has nothing added to it, and may be regarded as fairly typical English coal gas of good quality, consumes, as shown above, 1·13 volumes of oxygen, and gives off 0·54 volume of carbonic acid and 1·2 volumes of aqueous vapour. Carburetted water gas of 22-candle power, and of the composition quoted by Mr. Glasgow in his evidence, would consume 1·15 volumes of oxygen and give 0·80 volume of carbonic acid. The slightly larger volume of carbonic acid given off by the water gas is certainly not a matter of any importance. The carbon and hydrogen, of which the gas almost wholly consists in either case, burn completely to carbonic acid and water, or if any products of imperfect combustion exist, their presence has never, so far as I know, been demonstrated, and they may for all practical purposes be disregarded. Experiments by Gelmuyden, in which animals were kept for several days in air so vitiated by the products of combustion of coal gas that a candle would usually have been extinguished in this air, produced no sensible effect on the animals, nor could any trace of carbonic oxide be found in their blood.

The fact that the ceiling is commonly blackened above a gas-flame might perhaps be appealed to as evidence that the combustion in an ordinary flame is not perfect. The blackening observed in London and other smoky towns is probably, however, not due to the gas at all, but to the soot present in the air. The current of warm air from a ventilating apparatus has exactly the same effect on ceilings and walls as the warm air striking the ceiling above a gas-flame; and Aitken has shown that warm air deposits its particulate matter with great readiness on any cooler surface. In a country house where 38-candle cannel gas had been in use constantly for thirty years, I could not see any signs of blackening on the ceilings above the gas-jets, although high candle power coal gas is known to have more tendency to smoky flames than ordinary gas.

Both coal gas and carburetted water gas, even when purified, contain traces of sulphur compounds. These burn to sulphurous and sulphuric acids; and although these acids in the minute amounts present in the air of a room have no known effect on health, and are barely perceptible to the senses unless the gas is badly purified, yet they are of importance on account of their destructive action on metal and other materials. With respect to them also, however, it is of importance not to attribute to gas such effects as are probably in reality due to pollution of the air of towns by coal smoke. In dull and foggy weather in London and other towns, the amount of carbonic acid in the outside air is from one to ten volumes per 10,000 in excess of that in pure air. As this carbonic acid is derived chiefly from coal smoke, there must be an amount of sulphurous and sulphuric acid in the air corresponding in quantity to the sulphur in the coal burnt to produce the carbonic acid. For each volume of carbonic acid present, there will be about thirty times as much sulphurous and sulphuric acid in air contaminated with coal smoke as in air contaminated by the combustion of properly purified coal gas. The air of a room is seldom contaminated to the extent of more than about 20 volumes per 10,000 with carbonic acid derived from gas; so that it seems very clear that the contamination of the outside air by the sulphur of coal smoke is in towns like London a more important matter than the contamination of the inside air from combustion of gas.

Carburetted water gas has been stated to contain, when purified, much less sulphur than coal gas. It may, however, be pointed out that the official analyses (quoted in Mr. Humphreys' evidence) of the sulphur in New York carburetted water gas do not show that the carburetted water gas contains strikingly less sulphur than well-purified coal gas. The average is about 8 grains per 100 cubic feet. According to Mr. Lewis Wright well purified coal gas should contain about 7 to 10 grains. The average of the series of analyses in an official report on the coal gas of 56 Massachusetts Companies in 1884, before the introduction of water gas, was only 9 grains.

The subjects of Appendices II. and III. are mentioned in the opening paragraph; and, if considered necessary in conjunction with our summary of the evidence, extracts therefrom will be made on a future occasion.

APPENDIX IV.—WATER GAS AT BIRMINGHAM AND BLACKBURN.

Included in Appendix IV. is a statement, submitted by the Birmingham Corporation Gas Committee, on the supply of carburetted water gas in that city. They state the reasons which led them to the conclusion that the process could be safely adopted as an auxiliary to the manufacture of coal gas. Illustrating one of the advantages, they mention that the whole of the generating, condensing, and scrubbing plant from water gas of a capacity, including reserves, of about 9 million cubic feet per day which they erected, is covered by a roof removed from a dismantled retort-house, capable of producing only 1¼ million cubic feet of coal gas a day. One of the other considerations was the cost. The outlay on plant capable of producing 6½ million cubic feet per day, with the necessary plant for 2½ million cubic feet in reserve in case of accident, has been £100,000; whereas the cost of coal-gas plant for 6½ million cubic feet, with required reserve, would have been not less than £210,000. The plant, or a portion of it, was put into operation for the winter of 1896; and from the time it was first used to March 31, 1897, the output from it, as compared with coal gas, was—Saltley: Coal gas, 1,073,593,000 cubic feet; carburetted water gas, 125,619,000 cubic feet. Windsor Street: Coal gas, 1,050,594,000 cubic feet; carburetted water gas, 110,548,000 cubic feet. Excluding the make of coal gas at the Adderley Street and Swan Village works, the percentage of carburetted water gas to coal gas issued from the Saltley and Windsor Street works combined were, in the period named: Highest weekly 15·2, lowest weekly 1·2, highest daily 17·7, lowest daily while carburetted water-gas plant was in use 0·8—average during the period 11·1. The carburetted water gas produced during that time cost into holder 14·32d. per 1000 cubic feet of gas of an average illuminating power of about 18·3 candles; the cost of coal gas into holder in this period was 13·26d., of about 17·3 candles. Between March 31 and Sept. 30, 1897, the plant was occasionally used. Combining the two stations, the production of coal gas was 1,521,466,000 cubic feet, and of water gas 17,459,000 cubic feet. The percentage of carburetted water gas on total output was: Highest weekly 10·3, lowest weekly 8·8, highest daily 15·2, lowest daily when carburetted water-gas plant was in use 7·7. Early in 1897, the Committee resolved to enlarge the carburetted water-gas plant to a capacity equal to one-third of the output of coal gas with which it is mixed, with the necessary plant in reserve for safe working. This additional plant, or part of it, was in operation during the winter 1897-8. The issue from Sept. 30 to Dec. 31, 1897, was as follows, again combining the two works: Coal gas 1,241,678,000 cubic feet, carburetted water gas 224,445,000 cubic feet. Percentage of carburetted water gas on total output: Highest weekly 22·6, lowest weekly 4·5; highest daily 24, lowest daily when carburetted water-gas plant was in use 3·1—average 18·1. The Gas Committee expressed their intention of not exceeding an output of one-third of water gas to two-thirds of coal gas.

A statement by the Gas Committee of the Blackburn Corporation follows. They also dilate upon the advantages of the system; and in their case it is shown that the proportion of water gas to coal gas never exceeds one-third. It is submitted that the small admixture of carburetted water gas with the coal gas makes no difference, worthy of consideration, between the qualities and properties of the ordinary coal gas and the mixture they supply; and they would regard any measures which might be taken to prevent the manufacture of this gas as a most serious disaster to the finances of their large gas undertaking, and therefore to the ratepayers of the borough. This would be felt to all the greater degree in Blackburn because—firstly, owing to the high price at which the Corporation had to purchase the gas-works from the Blackburn Gas Company, in the year 1878, and, secondly, owing to the disastrous effects of the explosion which took place in Blackburn in the year 1891 (before the installation of carburetted water gas), which caused some loss of life and great damage to property, for which the Corporation were held by the Courts to be liable, and which cost them £14,000—the finances

* Details as to the method of using the blood-test for accurate quantitative determinations of carbonic oxide in air are given in the "Journal of Physiology," Vol. XXII., p. 465.

of the undertaking have been heavily weighted with capital, so that the price of gas at the present time is 3s. 7d. per 1000 cubic feet; the cost of capital representing 1s. 2d. per 1000 cubic feet of gas, as against an average of certainly not exceeding 6d. in most of the towns in Lancashire. The price of gas was raised in the year 1893 from 3s. 1d. to the present figure in order to provide for the explosion debt of £14,000, and for the loss on working, which had been occasioned previous to that by high prices of coal owing to strikes in the coal trade, and stoppage of works in mills and manufactories owing to disputes in the cotton trade.

APPENDIX V.—Carbonic Oxide Present in Various Samples of Gas.

The samples of gas referred to in the table forming this appendix were taken between April and July last year; and the percentages of carbonic oxide were found by Professor Ramsey to be as follows: Belfast 15·8, Bradford 9·4, Croydon 13·35, Garston 34·1, Glasgow 10·3, Leeds 8·8, Commercial Gas Company 6·9, Gaslight and Coke Company 10·9, South Metropolitan Gas Company 7·5, Oxford 8·6. Professor Ramsey points out that the Garston sample was carburetted water gas; and it is interesting to observe that the carbonic oxide contained in it exceeds 30 per cent. He regards this, however, as exceptional.

APPENDIX VI. is a miscellaneous collection of statements and communications by authorities on the subject, some of whom tendered evidence which will be noticed in future issues.

APPENDIX VII.—Poisonous Action of Coal Gas and Carburetted Water Gas. By J. Lorrain Smith, M.A., M.D., Lecturer in Pathology, Queen's College, Belfast.

The following experiments have been made with a view to determining whether the poisonous element in coal gas and carburetted water gas is carbon monoxide alone, or whether the illuminants, or any other constituent, should also be regarded as having a poisonous effect. The question to be decided was whether, in cases of poisoning by coal gas due to the percentage of the gas in air breathed, the effect of other constituents than carbon monoxide comes into consideration. Certain constituents, such as benzene, are known to be poisonous in large doses. We have here, however, to consider only their effect when present in such amounts as would occur in an atmosphere rendered just poisonous by an accidental leakage of gas.

In the earlier experiments of the series, the percentage of the gases supplied to the animals was low; and in the first few observations, no effect was noticed. The amount supplied was then increased, until the air breathed contained so much gas that the animal became collapsed in from ten to fifteen minutes. The effect of the coal gas was first observed where the carbonic oxide had reached a percentage at which the same effect would occur if it alone were present in the air in the same proportion. This effect was perfectly familiar to me from numerous experiments previously carried out for other purposes.

The observations on coal gas and carburetted water gas were made comparable by supplying at each stage of the experiments equal quantities of carbonic oxide. The experiments were arranged and carried out in consultation with Mr. James Stelfox, M.Inst.C.E., Manager of the Belfast Corporation Gas-Works, who also furnished the samples of the different gases used in the experiments. Mr. A. Percy Hoskins, F.I.C., Chemist to the Belfast Corporation Gas-Works, not only made the analyses of the gases, but gave me much assistance with the experiments. A few experiments on the effect of individual hydrocarbons were carried out. The gases observed were marsh gas, ethylene, and benzene vapour. The marsh gas and ethylene were made and analyzed by Mr. Hoskins. The benzene was obtained by volatilizing ordinary liquid benzene.

The apparatus used in the experiments consisted of a perfectly air-tight animal chamber through which an air current was passed. The rate of the current was measured by a meter. Into the current, before it entered the animal chamber, was introduced, through a T tube, a side stream consisting of the gas whose effect we proposed to study. This was, therefore, thoroughly mixed with the air current before it entered the chamber. This side current was obtained by displacing the gas from a two-litre cylinder by a current of water which was allowed to flow in from a small reservoir at a slightly higher level. The rate of flow of the water was adjusted by a stop-cock, so as to give the amount of gas required, and observations were taken at frequent intervals throughout the experiment to make certain that the rate of displacement of the gas by the water was uniform. The air current through the animal chamber was kept up by an aspirator fixed on a water tap. The variations in both currents during an experiment were practically *nil*.

Experiment I.—*Coal Gas.*

Analysis { 5·0 per cent. carbonic oxide.
4·1 per cent. illuminants.

The experiment lasted 45 minutes; and during this time 0·4 per cent. coal gas was supplied to the current of air breathed. The animal was therefore breathing 0·02 per cent. carbonic oxide and 0·016 per cent. illuminants. There was no visible effect.

Experiment II.—*Coal Gas.*

Analysis { 4·4 per cent. carbonic oxide.
4·0 per cent. illuminants.

The experiment lasted 2 hours 25 minutes, during which time the animal breathed air containing 2·08 per cent. of coal gas, yielding 0·09 per cent. carbonic oxide and 0·08 per cent. illuminants. There was no definite effect.

Experiment III.—*Coal Gas.*

Analysis { 4·2 per cent. carbonic oxide.
4·3 per cent. illuminants.

The animal breathed air containing 4·07 per cent. of this gas, giving 0·17 per cent. carbonic oxide and 0·17 per cent. illuminants. After 1 hour 8 minutes, the animal was drowsy, and had difficulty in co-ordination. Its respirations were deeper than normal. The rate was 112 per minute. On being taken out, after 1 hour 15 minutes, it did not move about freely. It shivered; but this may have been due to cold, as its temperature was 35° C. In ten minutes it apparently had completely recovered.

Experiment IV.—*Purified Carburetted Water Gas.*

Analysis { 28·5 per cent. carbonic oxide.
12·6 per cent. illuminants.

In this experiment a guinea pig breathed an atmosphere containing 0·63 per cent. of gas, giving 0·18 per cent. carbonic oxide and 0·079 per cent. illuminants. After one hour, the animal became drowsy and disinclined to move about, though at first it was restless. The respirations, after one-and-a-half hours, were deeper than normal. It was taken out after two hours, and recovered in a manner similar to that of the animal in Experiment III.

Experiment V.—*Purified Carburetted Water Gas.*

The same sample of gas was used as in Experiment IV. The air current contained 0·71 per cent. of the gas, giving 0·20 per cent. carbonic oxide and 0·089 per cent. illuminants. After 45 minutes, the animal began to lose its power of moving about, and sat in a constrained attitude, as if it were resting the whole body on the floor of the respiration chamber. Its breathing was increased in depth. It was taken out after 2 hours 6 minutes. During the last half-hour of the experiment, it had remained unchanged. It lay quite still on the floor for four minutes when taken out of the chamber, and then began to sit up in a natural attitude. One minute after it began to walk spontaneously, though in an awkward manner. It had shivering. Rectal temperature 32° C. Temperature four hours later 38·4° C.

Experiment VI.—*Coal Gas.*

Analysis { 5·6 per cent. carbonic oxide.
4·0 per cent. illuminants.

The animal breathed an atmosphere containing 3·62 per cent. of coal gas, giving 0·20 per cent. carbonic oxide and 0·14 per cent. illuminants. After one hour it was drowsy. After 1 hour 47 minutes it had little power of co-ordination. When disturbed it recovered equilibrium very slowly. It lay on the floor when taken out, after two hours exposure to this gas. In four minutes it began to assume the sitting position. In six minutes it could sit up. It commenced to move freely in eleven minutes, and to eat greedily. The rectal temperature when it was taken out was 32·5°C.

Experiment VII.—*Purified Carburetted Water Gas.*

Analysis. { 26·4 per cent. carbonic oxide.
12·9 per cent. illuminants.

A guinea pig breathed 1·70 per cent. of this gas, yielding 45 per cent. carbonic oxide and 0·21 per cent. illuminants. The experiment began at 2.35 p.m. 2.48, animal is a little unsteady in movement; 2.49, cannot stand; 2.51, collapsed (experiment stopped); 2.52, began to recover its feet; 2.55, began to walk about; no ill effects to be seen later.

Experiment VIII.—*Purified Carburetted Water Gas.*

The same sample was used as in Experiment VII. A guinea pig breathed air containing 1·63 per cent. of this gas, giving 0·43 per cent. carbonic oxide and 0·21 per cent. illuminants. This experiment began at 2.57 p.m. 3.8, guinea pig is becoming collapsed; 3.9, lies flat on abdomen; 3.10, lying on its side; 3.11, made an attempt to recover its position and failed; 3.12, experiment stopped; 3.13, animal recovered its feet; 3.17, began to walk voluntarily; recovered completely.

Experiment IX.—*Coal Gas.*

Analysis { 5·8 per cent. carbonic oxide.
3·6 per cent. illuminants.

The animal breathed air containing 7·6 per cent. of this gas, giving 0·44 per cent. carbonic oxide and 0·27 per cent. illuminants. The experiment began at 2.51 p.m. 2.55, guinea pig effected, shivering; 2.57, sprawling a little; 2.59, breathing deeper, still sits up; 2.59½, when disturbed recovers equilibrium slowly; 3.0, can just move; 3.1, lies on its side, still sprawls; 3.1½, collapsed (experiment stopped). On being taken out, the animal refused to lie on his side on the floor. At 3.3 sat up, and at 3.4 moved away. The guinea pig here was not so much affected as in Experiment VIII.; but the exposure had not been quite so long.

The experiments which follow are on the effect of individual hydrocarbons:—

Experiment X.—*Marsh Gas.*

Analysis { CH_4, 97·3 per cent.
Air, 2·7 per cent.
No evidence of CO, C_2H_4 or H_2 being present.

A cylinder holding 1300 c.c. was filled with the following mixture of gases: 520 c.c. CH_4, 130 c.c. O_2, 650 c.c. air. A mouse was put in this mixture of gases, in which half the nitrogen of 1300 c.c. of air had been replaced by CH_4. It remained in it for 42 minutes without any effect being apparent; and the experiment was stopped.

Experiment XI.—*Marsh Gas.*

The cylinder was filled with 260 c.c. O_2, and up to 1300 c.c. with CH_4. A mouse was placed in this mixture of gases, and remained in it for 40 minutes without showing any effect.

Experiment XII.—*Ethylene.*

Analysis { 91·9 C_2H_4.
1·8 per cent. CO.
(The percentage of carbonic oxide was determined by the carmine method.)
Qualitative tests showed the presence of CO_2 and O. SO_2 was absent.

A litre cylinder was filled with the following mixture: 100 c.c. C_2H_4, 50 c.c. O, made up to 1000 c.c. with air. A mouse was put in this at 12.50 p.m. 1 o'clock, seems to have less power in walking; 1.13, walks still, but with difficulty; 1.27, no change; 1.50, removed from chamber, recovered at once, and ran about quite easily.

Since this mixture contained 1·8 per cent. carbonic oxide, it was impossible to proceed with this sample of gas to test the effect higher than 9 per cent. Higher percentages rapidly produced the narcotic effect of carbon monoxide. Ethylene is the chief illuminant present in coal gas; and even in this experiment the animal was getting a dose fully twice as great as would be obtained if it were breathing an atmosphere composed entirely of coal gas.

EXPERIMENT XIII.—*Benzene.*

A guinea pig was exposed to the action of benzene in the following manner: It was placed in the chamber, and supplied with 1·5 litres of air per minute. Into this current was introduced a small side current of air saturated with benzene. This current was a steady one, of about 100 c.c. per minute; and during the course of the experiment 453 c.c. of benzene vapour was volatilized into the total volume of 69 litres of air. By this means air containing 0·65 per cent. of benzene vapour was supplied to the animal. Since the benzene present in coal gas is said to be about 1 per cent., this percentage would be equivalent to that of an atmosphere containing 65 per cent. of coal gas. The animal showed no symptoms whatever.

Conclusions.

From the above experiments, it is clear that the poisonous effect of coal gas, or water gas, is due to the carbon monoxide which is present. The effects on the guinea pigs were simply those of carbon monoxide poisoning. The effect of other constituents was not observed to modify this in any way.

In particular it should be noted that the effect of 7·6 per cent. coal gas, containing 5·8 per cent. carbonic oxide (Experiment IX.), is practically the same as that of 1·7 per cent. carburetted water gas, containing 26·4 per cent. carbonic oxide (Experiments VII. and VIII.). In other words the toxicity of the carburetted water gas was 4½ times as great as that of the coal gas; and the relative toxities correspond exactly to the respective percentages of carbon monoxide.

The experiments on the isolated hydrocarbons suffice to show—

(1.) That marsh gas may be used to replace the nitrogen of the air (79 per cent.) without any effect being produced.

(2.) That ethylene at 9 per cent. has no visible effect after one hour's exposure to it, though this percentage is at least double the amount of the gas present in ordinary samples of coal gas.

(3.) That benzene, which is known to have very distinct toxic effects when present in a quantity sufficient to saturate the air, has, at percentages far beyond that likely to be present in an atmosphere contaminated by a leakage of coal gas (0·65 per cent.), no visible effect.

It seems unnecessary to investigate further the isolated hydrocarbons, since they are not present in a quantity sufficient to make them factors in producing the poisonous effects of coal gas.

CRYSTAL PALACE DISTRICT GAS COMPANY.

The Half-Yearly General Meeting of this Company was held last Friday, at the Albion Tavern, Aldersgate Street, E.C.—Mr. GEORGE LIVESEY in the chair.

The SECRETARY (Mr. Charles M. Ohren) having read the advertisement calling the meeting, it was agreed to take as read the Directors' report and the accounts, which were noticed in last week's issue.

The CHAIRMAN, in moving the adoption of the report and the accounts, said he might settle this portion of the business of the meeting in a short and decisive manner, and save a great deal of time, by simply saying that the report was one with which the Directors were thoroughly satisfied, and they had no doubt the proprietors were equally so. But he supposed they would hardly be contented if he sat down with these few words. It was the practice of the Board to give in the report as full a statement as practicable in a short compass of the position of the Company; and he might also say it was their practice to give a perfectly true and candid statement to the proprietors. If at any time, as had happened during the last year or two, the Company had not been in so satisfactory a position as they would have liked, the Directors had said so; and now he thought he might ask the proprietors to believe him when he said that the Company had "turned the corner," the position was a satisfactory one, and they had every reason to hope it would continue to grow better. Some years ago, they were selling gas at 2s. 6d. per 1000 cubic feet; but in 1892, they raised it to 2s. 9d. In 1894, it was brought down a penny, and in 1895 a further penny; the price now being 2s. 7d., at which it had stood since 1895—rather more than three years. He did not think the Directors would be contented to sell gas at a higher figure than they had sold it at some previous period. He should have something more to say on this subject. But he mentioned it here to show there was something to which they had to aim; and, if prosperity continued as it had done during the last six months, it would not be very long before they had an important announcement to make in regard to the price. The first paragraph in the report stated that one cause—the main cause, he might say—of the favourable accounts had been the considerable increase in the receipts for coke and ammonia. In past years, when these products had sold very badly, the Directors had told the proprietors that it was a matter beyond their control; and, on the present occasion, they said the same thing. They did not wish to take any credit to themselves, or for the management, for any result over which they had no control; and they had no control practically speaking over the prices of coke and ammonia. Therefore the benefit they had derived from the improved values of these products was due to circumstances for which they did not take credit. But there had been improvements in many other directions for which they might take credit. For instance, there was an improvement in the cost of manufacture—the carbonizing wages showing a reduction. Twelve months ago, the carbonizing wages worked out to 3s. 4d. per ton of coal; while this year they came out at 3s. 1d. But 3d. did not represent the whole of the difference; for during the half year, the Directors had thought it right to make an increase of 7½ per cent. in the wages of the stokers. This increase only took place in October; but it was equivalent to 5 per cent. on the wages during the whole of the half year. Adding this 5 per cent. to the 3s. 4d., they had 3s. 6d. as the cost of carbonizing. Therefore the improvement that had been effected amounted to as much as 5d. per ton of coal, or a total of nearly £1200. But the whole of this gain was not due to one cause. Part of it was attributable undoubtedly to the extension of machinery, and a larger use of the machinery which they already possessed. Another part was due to the better arrangements effected by the Engineer, and to improved and more willing work on the part of the men. He had had occasion at one of the meetings to say that the Board were disappointed with the work of the stokers; that they were not working with the good will the Directors had expected. He had now very great pleasure in saying that they had responded to the efforts of the Engineer; and it was by the extended use of machinery, and the united efforts of the Engineer and men, that the carbonizing wages had been reduced to the equivalent of 5d. per ton of coal. This, he thought, was very satisfactory. Then, again, though they had been doing a great deal in the way of renovating the plant, the cost of repairs and maintenance was 2d. per ton less than in the corresponding half of 1897. In some of the items, too, improvements had been made; and the total result was a very satisfactory surplus on the revenue account—a surplus which enabled them to make good the deficiency on the June half year. They then took from the reserve fund something like £900; but the profits of the December half allowed them to make good the amount, and carry forward £1200 to the next accounts. The effect on the reserve fund was that they increased it by £1674—that was, £1327 was added in the accounts, and there would be £346 17s. 6d. additional, which would bring the reserve fund up to rather more than £34,000. Considering that two years ago, the fund was £40,000, and that it was reduced in 1897 by something like £8000, the figures he had quoted showed they were now recovering; and, in a short time, by the increments of interest, and by the small amount of dividend unpaid—dividend to which the proprietors were entitled, but which was not distributed, and which reached about £700 a year—they hoped to restore the fund to the original figure. In the second paragraph of the report, there is a statement about the increase in the consumption of gas; and in respect to this he wished to make a correction. The increase was stated in the report to have been 7 per cent.; but it was really 6½ per cent., and was due to two or three causes. One was the large addition to the number of slot meters—about 1400 in the year; and equally satisfactory was the increase in the ordinary consumers of about 550. Now the prepayment and ordinary consumers, of course, accounted for a considerable part of the extra sale of gas; but happily not for the whole. He believed that two-thirds might be attributed to the new consumers; and this gave them about 2 per cent. increase from the old consumers. He regarded this as one of the most gratifying items in the accounts; showing, as it did, that their old customers were still continuing to increase their consumption. Reverting to the advance which they had made in wages, he said that the stokers in the summer time applied to the Directors for an increase of pay, on the ground that general wages had risen very materially of late years. Stokers' wages, he might observe, were not increased as were ordinary labourers' wages. They were at a fixed figure; and must all be advanced at once, if advanced at all. The men came to the Directors in a fair and reasonable manner, and urged that, as they thought the proper time had come, an advance might be given to them. At the time the Directors refused; but, later on, other circumstances—not coercion or pressure, the men having accepted the Directors' refusal in a very proper spirit and with good grace—came to the knowledge of the Board which led them to consider that the time had then come, acting in accordance with the law of supply and demand, when an advance should be made; and consequently they gave the stokers an increase of 7½ per cent., or 5d. per day from October. Their Company, with one other Company, were the leaders in this matter; and the only remark he would make about it was that a request of this sort coming from one's own men was a very different thing to a demand made by a Trade Union. The stokers came to the Directors as men to men, and put their case fairly and reasonably, and without threats of ulterior proceedings. The matter was settled amicably and satisfactorily he believed all round—at any rate, the men had shown their appreciation of it by working in good spirit, and the Company had the considerable reduction of 5d. per ton in their carbonizing wages. When speaking of the price of gas, and the possibility, if circumstances remained favourable, of an early reduction, he intended to add a few remarks on another subject. It was this: The cost of enriching the gas had been rather a serious matter in the course of the year. They had used something like 42,000 gallons of petroleum spirit, which cost about 8d. per gallon, or a total of about £1400 a year. This was what they had to spend on enrichment; and this enrichment was carried out solely and entirely for the benefit of Beckenham. The Company were supplying two qualities of gas. They had a separate main running to Beckenham, and other mains to the other parts of the district. The gas supplied to Beckenham had to be tested there, two miles from the works. It was well known that gas lost a certain amount of its illuminating power in travelling through pipes; it had been recognized and accepted by Parliament ever since Dr. Letheby's time, 40 years or more ago. Therefore, gas sent out from their works of a quality of 15 candles would, probably, at a distance of (say) two miles from the works, be of only 14-candle power. The Beckenham people were the only real opponents when the Company last had a Bill in Parliament; and they made it a condition that the gas should be tested in Beckenham. Consequently, to ensure the supply of 15-candle gas in Beckenham, they had to enrich it to 16 candles, sometimes a little more or less. Now it came to this, the other parishes were perfectly content with gas of 15-candle power sent out from the works; and the whole of the £1400 which they spent on petroleum spirit for the enrichment of the gas supplied to Beckenham was entirely for the benefit of the people there. The joke of it was that it did not do the gas any appreciable amount of good, and the Beckenham people did not get any real benefit from it. The gas supplied to Lewisham, parts of Croydon, Lambeth, and Camberwell was just as good to the consumer, and answered his purpose quite as well as the enriched gas did the consumer in Beckenham. In what he was going to say, he was not speaking for the Board, but was merely expressing his own view. It did not seem to him that it was fair to make their consumers in Lewisham, Croydon, Lambeth, and Camberwell pay for this enrichment of the gas supplied to Beckenham. If the consumers of Beckenham wanted gas of higher quality, they ought to pay for it; and the natural result was this: When the Company made their next reduction in price (it would only be 1d.), in common fairness, it ought to be made in Lewisham, Croydon, Lambeth, and Camberwell; and the price charged in Beckenham should remain as at present. There was an alternative. If the Beckenham people would be content to have the same quality of gas as all the other parishes, then the Company would supply the consumers there at the same price. This matter had never been made public before; and he thought he was right in making it so now, because he considered the other parishes should be told that, if they were satisfied with 15 candles at the works, they ought not to pay the price

of 16-candle gas. He had delivered his soul; but he fancied some people would say it was a very outrageous doctrine that they should charge two prices. There was not the slightest reason in this case why they should not do so; but it would have this effect, so far as the shareholders were concerned. Supposing they reduced the price to 2s. 6d. in the contented parishes, and left it at 2s. 7d. in Beckenham, he did not think it would be safe to pay the dividend due to the 2s. 6d. price. But as it was not the policy of the Board to pay the dividend up to the hilt, this would practically make no difference to the shareholders, seeing that they were now paying a dividend 1d. short of the price. There was one other point in regard to this matter to which attention might be drawn. The shareholders and the consumers were partners. The sliding-scale made them as truly and actually partners as anything could do. What was the consumers' interest was the shareholders' interest. It was to the interest of the consumer to have cheap gas; and it was to the interest of the shareholders to supply it. The shareholders' interest consisted in this: That, if they could reduce the price of gas, they were entitled to a slightly increased dividend. By a penny reduction in the price, the consumers would get £4200 a year; but the shareholders would only get one-sixth of that, or just under £700. In making a penny reduction, they would be entitled to this one-sixth; and they could take it either in meal or malt. They could put it in their pockets, or add it to the reserve fund. Let it be borne in mind that the proportion was six to the consumer and one to the shareholder. Therefore any extra cost in the manufacture of gas had to be paid for by the consumers at that rate. For instance, of the £1400 paid last year for enriching oil, £1200 was paid by the consumers, and £200 by the shareholders so to speak. Therefore it seemed to him it was to the general interest both of the shareholder and the consumer to reduce the price of gas by all possible means.

The Deputy-Chairman (Mr. Frederic Lane Linging) seconded the motion.

Mr. S. Mack said he had been much interested in the Chairman's opening remarks with reference to the bye-products; and he should like to say that a company with which he was connected disposed of all their coke through one firm of coal and coke merchants. The plan answered admirably, and paid well; the Company having to keep no horses, carts, or carmen. It occurred to him that, if it answered in one case, it would in another. He merely threw this out as a suggestion.

The Chairman said he was much obliged for the suggestion; but he was afraid it was hardly practicable in their case. The quantity of coke they had to deal with was considerable; and they had a large number of customers. He had never heard of a company putting their coke in the hands of one contractor in that way. One of the advantages of these meetings was to get suggestions from the shareholders; and this was information at any rate.

Mr. Mack remarked that he referred to the Sutton Gas Company, which, as the Chairman knew, was for years well managed by their late friend Mr. Mead.

The motion was unanimously carried.

The Chairman proposed the declaration of a dividend at the rate of 5 per cent. on the preference stock, and 5¼ per cent. on the ordinary stock, less income-tax. He remarked that the ordinary shareholders were really entitled to 5⅜ per cent.; and the dividend recommended was ⅛ less, which gave them £346 to add to the reserve fund.

Dr. Frederic Hetley seconded the proposition, which was passed.

On the motion of the Chairman, seconded by Mr. A. T. Layton, the retiring Directors (Mr. F. L. Linging and Mr. C. Lea Wilson) were re-elected. The Chairman mentioned that Mr. Linging had been on the Board 38 years.

Mr. T. Guyatt next proposed, and Mr. W. H. Coe seconded, the re-appointment of the outgoing Auditor (Mr. Alfred Lass); and this was also agreed to.

Mr. H. D. Ellis remarked that through good and bad times, the Chairman and Directors had always earned the gratitude of the shareholders; but he was sure the latter had not passed a vote of thanks to them with greater pleasure for a considerable number of years past than they would do on this occasion. Speaking of the administration of their affairs by a body of gentlemen who thoroughly understood their business, he referred to the slovenly manner in which cables for electric lighting had been laid in the thoroughfare in which he resided at Upper Norwood, following upon the Local Authority becoming the purveyors of electricity in the district. The discomfort to the public had been unprecedented; and now, he understood, that owing to the faulty way in which the cables had been laid, all the trenches were to be re-opened. He suggested that the Directors should follow the example of another Company of which Mr. Livesey was Chairman, and hold all future meetings at some central place.

Mr. J. G. Robinson seconded the motion, which was heartily agreed to.

The Chairman acknowledged the cordial manner in which the vote had been passed. Continuing, he remarked that the officials, foremen, and a large proportion of the workmen were animated by the right spirit; and he had much pleasure in proposing that the best thanks of the proprietors be accorded to them.

Mr. Simpson Rostron seconded the motion, which was unanimously adopted.

The Engineer (Mr. S. Y. Shoubridge), in responding, said the officers and men had been very pleased with the improvement in the affairs of the Company, because they had endeavoured to show in the past half year that the generosity of the Board and proprietors in permitting their employees to participate in the profits of the undertaking, had been duly appreciated by them; and they were exceedingly glad to notice that the Board in their report had recognized that this spirit had had its effect upon the working.

The Secretary (Mr. Ohren) also acknowledged the vote on behalf of himself and his staff.

The Stockport Corporation and the Water-Works.—An extraordinary meeting of the Stockport Water Company was held on Monday last week; Mr. George H. Hill presiding. Some time was occupied in reading and approving an agreement with the Stockport Corporation to purchase the concern for £750,000. The Bill by which the necessary power is sought provides for the Corporation taking over all the Company's plant and officials, and paying the latter on the same scale as at present.

SHEFFIELD UNITED GAS COMPANY.

The Half-Yearly Report and Accounts.

At the forthcoming half-yearly meeting of the above Company, the Directors will report an increase to the extent of 88,474,000 cubic feet, or 7·8 per cent., in the quantity of gas sold during the six months ending Dec. 31 last, as compared with the corresponding period of 1897. The sale of gas produced £107,386; rental of meters and stoves, £6204; and residuals, £44,448—the total being £159,984, against £158,692 for the latter half of 1897. The manufacture of gas cost £94,639; distribution, £13,704; and management, £4804—the total expenditure being £123,031, against £110,571. The balance carried to the profit and loss account is £36,953, as compared with £48,121 this time last year. The profit for the half year is short of the amount required to pay the usual dividend by £4008; but as the reduction in the price of gas of 2d. per 1000 cubic feet on the quantity sold during the period covered by the report amounts to £10,074, the Directors consider the result satisfactory. The balance of net profit is £59,671. The dividends on the various classes of stock will absorb £41,687, and leave a balance of £17,984 to be carried forward. The new works at Grimesthorpe being sufficiently advanced, the manufacture of gas has been carried on there since October. The quantity of coal and cannel carbonized in the past half year was 128,190 tons; the residuals produced being 77,050 tons of coke and breeze, 7387 tons of tar, and 3,862,000 tons of ammoniacal liquor.

BRISTOL GAS COMPANY.

The Half-Yearly General Meeting of this Company was held last Friday, at the Offices, Canons' Marsh—Alderman J. W. S. Dix in the chair.

The report and accounts, noticed in the "Journal" for the 7th inst., having been taken as read,

The Chairman moved their adoption. In doing so, he remarked that the undertaking was progressing, the output of gas was increasing, and altogether they were in a more than fairly prosperous condition.

Mr. R. D. Robjent seconded the motion; and it was carried.

The retiring Directors and Auditor having been re-elected, a dividend of 5 per cent. per annum on the nominal capital of the Company was declared.

A Special General Meeting was then held to consider the Bill to enable the Company to erect additional works for the storage of gas, raise additional capital, and for other purposes.

The Solicitor to the Company having read the heads of the Bill,

The Chairman moved a resolution approving of the measure. He pointed out that the works had had to be extended in the past few years by the erection of new gasholders, and now the time had come to put up a holder at Horfield. It was absolutely necessary that they should do this work so as to be able to keep pace with the demands made upon them. He need hardly say that the increase in storage capacity and the extension of mains, &c., meant that capital was necessary. They were now in such a position that they thought it desirable to go to Parliament to raise additional capital as required from time to time; and the Bill, except in other matters of detail, was really to enable them to raise £300,000 by auction. They also asked for powers to supply gas-stoves, dynamos, and other things. This seemed to have irritated their electrical friends in the city, who appeared to want to have a monopoly. But he contended that the Company only made a reasonable claim in asking to be allowed to supply gas for motive power at a different rate from that charged for it as an illuminating agent. This would enable the Company to fairly compete with the Corporation, whereas at present they had their hands tied.

The Deputy-Chairman (Mr. G. K. Stothert) seconded the motion, and it was carried.

A vote of thanks to the Chairman and Directors brought the business to a close.

CROYDON COMMERCIAL GAS COMPANY.

The Half-Yearly Report and Accounts.

The Directors of the above-named Company will report at the half-yearly meeting to-morrow, an increase of 0·93 per cent. in the quantity of gas sold in the six months ending Dec. 31 last, as compared with the corresponding period of 1897. The smallness of the increase is accounted for by the exceptionally mild weather which prevailed during the last quarter. Although the quantity of gas sold is greater, the expenditure for coal, oil, labour, &c., has been considerably less; and notwithstanding the reduced quantities of residuals made, owing to the manufacture of carburetted water gas, it is very satisfactory to find that there has been an increase in the receipts under this head of £520, attributable to the better prices obtained for coke and sulphate of ammonia. There was an increase of 363 ordinary consumers and of 452 prepayment and automatic meter consumers during the half year; making the total 13,261. Additional gas cooking and heating stoves to the number of 425 have been fixed; making the total now supplied on hire 5316. The accounts accompanying the report show that the sale of gas produced £44,043; the rental of meters, stoves, and fittings, £2966; residual products, £12,494—the total revenue being £59,577. The expenditure on the manufacture of gas was £30,383 (coal, oil, &c., costing £19,283); on distribution, £5203; and on management, £2157—a total of £42,430. The balance carried to the net revenue account is £17,146, compared with £14,888 this time last year; and the amount available for distribution is £16,831, against £14,727. The Directors recommend dividends at the rate of 14 per cent. per annum on the consolidated "A" stock, 11 per cent. per annum on the "B" stock, and 9 per cent. per annum on the "C" stock and Carshalton capital, all free of income-tax. The payment of these will absorb £15,447, and leave a balance of £1384 to be carried forward. Under the supervision of Mr. J. W. Helps, the Company's Engineer and Manager, 22,612 tons of coal, 6 tons of cannel, and 265,144 gallons of oil were used in the production of 340,084,000 cubic feet of gas, of which 317,501,100 cubic feet were sold and 321,369,100 cubic feet accounted for. The estimated

quantities of residuals produced were: Coke, 13,570 tons; breeze, 3500 tons; tar, 280,171 gallons; and ammoniacal liquor, 632,731 gallons—the make of sulphate being 242 tons, of which 175 tons were sold.

TOTTENHAM AND EDMONTON GAS COMPANY.

The Half-Yearly Report and Accounts.

In the report which the Directors of the above-named Company will present at the half-yearly general meeting next Saturday, they state that in the six months ending Dec. 31, 1898, there was an increase of 22,809,900 cubic feet, equal to 9·29 per cent., in the consumption of gas, over the corresponding period of 1897. The total number of meters in use at the end of last year was 14,143, of which 7119 were ordinary and 7024 automatic; the increase in the twelve months being on ordinary meters 607, equal to 9·32 per cent., and on automatic meters 1284, equal to 22·37 per cent. The number of gas cooking-stoves on rent at Christmas, 1898, was 2348; the increase over the number at the corresponding period of 1897 being 377, or equal to 19·12 per cent. The accounts accompanying the report show that in the second half of the past year £6720 was spent on works and plant; bringing up the expenditure to £413,506, or within £16,193 of the total amount of called-up capital. The revenue from the sale of gas came to £40,024; from the hire of meters, stoves, and fittings, to £2856; and from the sale of residuals, to £4790—the total receipts being £47,681. The expenditure on the manufacture of gas was £26,718 (£8478 being for coal, and £6972 for oil and coke used in the manufacture of carburetted water gas); on distribution, £4757; and on management, £1845—the total expenses being £37,353. The amount carried to the profit and loss account is £10,328; and the balance available for distribution (including £1444 brought forward) is £10,663. The Directors recommend a dividend at the rate of 6 per cent. per annum on the "A" consolidated stock, and of 4½ per cent. per annum on the "B" stock, the payment of which will absorb £8929, and leave £1734 to be carried forward. The working statements show that, under the supervision of Mr. W. H. H. Broadberry, 12,055 tons of coal and 485,463 gallons of enriching oils were used in the manufacture of 278,479,000 cubic feet of gas, of which 268,142,000 cubic feet were sold and 272,973,000 cubic feet accounted for. The make of coke was 7233 tons, of which 2115 tons 8 cwt. were used in making coal gas, and 2862 tons 6 cwt. in producing carburetted water gas; of breeze, 1520 chaldrons, of which 833¼ chaldrons were utilized; of tar, 196,720 gallons, of which 171,338 gallons were sold; and of ammoniacal liquor, 3350 butts, of which 2928 butts were converted into sulphate of ammonia, the estimated quantity produced being 83 tons 14 cwt., of which 47 tons 14 cwt. were sold.

BROMLEY GAS CONSUMERS' COMPANY.

The Half-Yearly Report and Accounts.

In the report which the Directors of the above-named Company will present at the half-yearly general meeting next Thursday, they state that the quantity of gas made in the six months ending Dec. 31 last, was 4½ million cubic feet more than in the corresponding period of 1897; while there was a sustained improvement in the prices realized for coke and sulphate of ammonia. The additions to the manufacturing capacity of the works, under the supervision of the Engineer (Mr. W. Woodward), which have been in progress during the past three or four years, are now practically finished; and the Directors state that they have given very satisfactory results, and will enable the Company to meet the growing requirements of the district for some time to come. The accounts accompanying the report show that the receipts for gas amounted to £16,781; residuals produced £5588; and the total revenue was £23,191; the figures for the corresponding period of 1897 being £16,397, £4143, and £21,327 respectively. The expenditure on the manufacture of gas came to £12,208; on distribution to £422; management cost £1534; and the total expenditure was £15,914—leaving £7277 to be carried to the profit and loss account. The corresponding expenditure in the six months ending Dec. 31, 1897, amounted to £11,304, £406, and £1485; the total being £14,945, and the balance £6382. The amount available for distribution is £8236; and the Directors recommend the declaration of a dividend at the rate of 12 per cent. per annum on the ordinary 10 per cent. shares, and of 9 per cent. per annum on the ordinary 7 per cent. shares (both subject to income-tax). These will absorb £6162, and leave a balance of £2074 to be carried forward. The statements relating to the working of the Company show that 11,733 tons 7 cwt. of coal and 17 tons 11 cwt. of cannel were carbonized in the latter half of last year; the make of gas being 117,558,000 cubic feet, of which 110,344,000 cubic feet were sold. The residuals produced were: Coke, 11,750 chaldrons; breeze, 2124 chaldrons; tar, 109,375 gallons; sulphate of ammonia, 93 tons 13 cwt.

SOUTH SHIELDS GAS COMPANY.

The Half-Yearly Report and Accounts.

The accounts to be presented at the annual general meeting of the above-named Company next Tuesday show a profit of £14,907, as compared with £17,531 this time last year; being a drop to the extent of £2624. The receipts for gas last year (360,989,100 cubic feet at 2s. 6d., and 17,028,600 cubic feet at 3s. 3d., together with the quantity supplied for public lighting and under contracts) amounted to £49,745; and the rental of meters, stoves, engines, and lamps, to £3991; the residuals produced £11,152; and the total revenue was £65,490. The expenditure on the manufacture of gas came to £38,815, on distribution to £3436, on management to £2679—the total expenses being £50,582. The balance carried to the profit and loss account is £14,907; and the amount available for distribution, £6098. The Directors recommend a dividend of 4¼ per cent., which, with the interim dividend of 4½ per cent. paid in September last, will make 8¾ per cent. for the year. As the half-year's statutory dividend amounts to £7871, there is a deficit of £1773; and in order to meet this, it will be necessary to draw £945 from the reserve fund, leaving ½ per cent. to stand over as an arrear. The Directors attribute the deficit chiefly to the increased cost of coals and labour. They regret that, owing to these causes, it will be necessary to increase the price of gas 2d. per 1000 cubic feet, to take effect from the beginning of the current year. This will necessarily reduce the statutory dividend by ½ per cent.—viz., from 9¼ to 8¾ per cent. per annum—according to the sliding-scale under which the Company are working. The Directors remark that there has been no material advance in the sale of gas; but the receipts for coke and ammonia show an increase of £2992. Better prices are now being obtained for both of these products; but the value of tar still remains low. There is a decrease on this item of £1123. Regretful reference is made by them to the loss of their valued and much-esteemed Chairman, Mr. Robert Wallis, who died during the past year. He had sat on the Board for the long period of about fifty years, for forty of which he ably filled the office of Chairman. He was most devoted to the Company's welfare. Dr. J. F. Armstrong, J.P., has been appointed his successor. The working statements show that 49,386 tons of coal and cannel were carbonized last year; the residuals produced being 30,765 tons of coke, 476,224 gallons of tar, and 494,300 gallons of ammoniacal liquor, of which 450,820 gallons were used for the manufacture of sulphate of ammonia.

PROVINCIAL GAS AND WATER COMPANIES.

Gas Companies.

The report of the Directors of the Airedale Gas Company for the half year ending the 31st of December last states that the profits during that period amounted to £1176, which, added to those for the June half of £1005, makes a sum of £2181 for the year. The total income on the year has improved by £174 over that of 1897. The Directors recommend the payment of a dividend at the rate of 5 per cent.

At the meeting of the Aldershot Gas and Water Company last Wednesday, the Directors reported that there had been an increase of 6·7 per cent. in the consumption of gas in the six months ending Dec. 31 last. This had been mostly from the private consumers; but there had also been better returns both from public lighting and from special contract supplies. Residuals had improved, in the aggregate, though the revenue from tar had fallen off considerably. The water revenue from all classes of consumers had been better. The satisfactory condition of the accounts, and the prospect of diminished expenditure on repairs, led the Directors to announce the reduction of 3d. per 1000 cubic feet in the price of gas as from the 1st ult., making it 2s. 6d., as notified elsewhere. Improvements had been effected at the gas-works; while the additions and repairs carried out in recent years at the water-works had allowed of pumping to the full requirements of the daily demand, either by steam or gas machinery. The Directors reported with satisfaction that the latter was preferably used, in regard to both facility and economy; the steam plant remaining principally as a reserve to meet contingencies. The balance available for distribution was £7245; and the Directors recommended a dividend for the half year at the rate of £11 13s. per cent. per annum on the "A" shares, of £8 13s. per cent. per annum on the "B" shares, and of 7 per cent. per annum on the "E" ordinary shares, all less income-tax.

The report which the Directors of the Bath Gas Company will present to the proprietors at the half-yearly general meeting next Friday opens with the gratifying statement that the accounts for the half year ended Dec. 31, 1898, show a balance of £8576, after closing the suspense account by a charge of £1500 to revenue account for renewals. Notwithstanding the warm and bright weather of the winter months of the half year, there has been a very satisfactory increase in the sale of gas, which has been considerably helped by consumers on the prepayment system. Better prices have been obtained for coke and sulphate of ammonia; but the low figure for tar, under a new contract from the 1st of July last, shows a reduction on this account. The Directors having resolved to reduce the price of gas by 2d. per 1000 cubic feet, and also to allow discounts to large consumers, announced this by advertisement on the 1st of December last. The reduction in price commenced with the present year; and the usual result—an increase in consumption—is looked for. The receipts from the sale of gas were £28,556; residuals produced £5513; and the total revenue was £36,023. The expenditure on the manufacture of gas was £21,317; on distribution, £2723; on management, £1454; and the total outlay was £27,447—leaving the balance mentioned at the opening of the report. The Directors recommend the declaration of maximum dividends. Under the supervision of Mr. C. Stafford Ellery, 19,507 tons of coal and 97,367 gallons of oil were used in the manufacture of gas (the quantity of which is not given) in the past half year; the residual products being: Coke, 11,529 tons; breeze, 1144 tons; tar, 1022 tons; and ammoniacal liquor, 557,000 tons—the make of sulphate being 173 tons, of which 151½ tons were sold.

The seventeenth ordinary general meeting of the Bromsgrove Gas Company was held on Monday last week—Mr. J. Green presiding. In their report, the Directors stated that the result of the past year's operations proved that the business of the Company was steadily increasing. The accounts showed an available balance of £1958, including £310 brought forward, with which it was proposed to pay a dividend of 7½ per cent. on the ordinary shares, and 7-10ths of 7½ per cent. on the "B" shares, for the year, free of income-tax, to increase the reserve account by £110, and carry forward the balance of £738 2s. 4d. In moving the adoption of the report, the Chairman said they had experienced what was perhaps the most progressive year in the history of the Company. The Directors were not unmindful of their duty to the public, and it had been decided to make a reduction in the price of gas from the 1st of July next. The Urban District Council would participate in this reduction, although their contract did not expire until the end of the year. The report was adopted, and the dividend recommended was declared.

The Directors of the Chelmsford Gas Company present a satisfactory report for the past year. The amount earned shows an increase of £290 on 1897. The total expenditure of the Company last year was £5595, and there was a sum of £3232 to be carried to the profit and loss account. There has been a further increase in the receipts from prepayment meters. At the end of last year the reserve fund stood at £1040. The Directors have decided to carry £360 out of profits to the credit of this fund, making it £1400. In addition to this, they have been able to reduce the suspense account to £300, by carrying to it £300 out of last year's

profits. They are gratified to find that there has been a substantial decrease in the leakage of gas, showing the improved state of their mains. The profit and loss account shows a balance available for distribution of £2869, against £2644 in the year 1897. The Directors recommend that the following dividends should be declared: 9 per cent. per annum on the original share capital, and £6 6s. per cent. per annum on the additional capital. The payment of these dividends will leave a balance of £230, which will be carried forward.

The half-yearly meeting of the Colchester Gas Company was held last Friday—Mr. C. Coleman presiding. The Directors presented a congratulatory report of the working. The make of gas during the six months ending Dec. 31 last, when compared with the corresponding period of 1897, showed an increase of 5,012,000 cubic feet, or 4·16 per cent., which was very satisfactory, considering the abnormally high temperature and prevalence of sunshine, as contrasted with former years. The increase in the Company's business necessitated the raising of fresh capital; and it was proposed to empower the Directors to borrow £1500 on mortgage. The revenue account showed a balance of £2159. The report was adopted; and it was decided that the usual dividend at the rate of 10 per cent. per annum on the old shares, and 7 per cent. on the new, should be paid for the past half year. Subsequently an extraordinary meeting was held, at which it was resolved to authorize the Directors to raise the additional capital required.

According to the report to be presented to the shareholders of the Eastbourne Gas Company at their meeting on the 27th inst., the revenue account shows a profit for the six months ending Dec. 31 last of £6329, which, added to £10,587 brought forward after payment of the dividend in August last, and £18 received for interest, makes a total of £16,934 to the credit of the profit and loss account. The Directors recommend a dividend for the past half year at the rate of 14½ per cent. per annum upon the £20,000 original capital of the Company, and also upon the £12,490 (the amount raised on the "C" shares), and at the rate of 11½ per cent. per annum upon the £65,000 paid-up capital on the "B" shares, which will absorb £6093, and leave a balance of £10,841 to be carried forward.

The ordinary general meeting of the Goring and Streatley District Gas and Water Company, Limited, was held last Wednesday, when the statement of accounts presented showed that the gas revenue for the past year was £809, and the expenditure £531; while the water revenue was £533 and the expenditure £294—the profits being £278 and £239 respectively. Out of the total—£517—interest on the debenture stock, less tax, has been paid, amounting to £193; and the balance added to the amount brought forward made a sum of £618 to the credit of the Company. This was disposed of by writing off £500 from the preliminary expenses, and carrying forward £118. The exceptional drought of the past two seasons caused some anxiety to the Directors; and in order to ensure a permanent supply of water to the increasing district, it became imperatively necessary to duplicate the steam power and pumping machinery, and to enlarge and extend the gas and water mains. This work has, they reported, been efficiently carried out.

The Directors' report read at the annual meeting of the Ipswich Gas Company yesterday shows a large increase in the receipts from the sale of gas, and a satisfactory rise in those from the sale of coke and sulphate of ammonia. There is, however, no improvement in the value of tar. On the other hand, nearly all the items of expenditure are higher, due to the Company's large and constantly growing business. The balance on the profit and loss account is £15,112, of which £4939 was used in payment of an interim dividend in September last; and the Directors recommended the declaration of a further dividend at the full statutory rates. A balance of £5233 will be carried forward.

The accounts of the Londonderry Gas Company for the year ending the 21st of December last, which will come before the shareholders at their meeting on the 3rd prox., show that the revenue was £17,152; the expenditure, £12,461; and the profit, £4691. Out of this sum the Directors recommend a dividend at the rate of 11 per cent. free of income-tax. This, after providing for all charges, will leave a surplus of £512 16s. 5d. to be placed to the credit of the current year's accounts. The Directors congratulate the shareholders on the continued prosperity of the Company. The consumption of gas increases from year to year in a most satisfactory way; the output now being nearly double what it was twelve years ago. The growing demand for gas has encouraged the Directors to reduce the price from 3s. 6d. to 3s. 3d. per 1000 cubic feet as from the 1st of January last. This is a large reduction to make in one year; but the Directors believe that the concession will further stimulate and develop the business, and cause gas to be used for various purposes in still increasing quantities.

The annual meeting of the Longwood Gas Company was held last Thursday—Mr. E. Armitage presiding. In moving the adoption of the report and accounts, he congratulated the shareholders upon the good result of the past year's working. The sale of gas was the highest on record; the quantity made being 56,290,100 cubic feet, and the make per ton of coal 10,224 cubic feet. The leakage account showed a substantial reduction. When Mr. Brearley took the position of Manager and Secretary, it was 16 per cent.; whereas now it was 8·8 per cent. The greatest possible credit was due to him for the manner in which he had conducted the works and the business of the Company. The increase in the consumers was 542; the total number being now 3351. Of these no less than 517 used prepayment meters, which, he might say, were giving excellent results. Last year they yielded £593. The Company had 140 stoves out on hire, giving satisfaction. Residuals showed an upward tendency; and the Directors were hopeful that, if the present price of sulphate of ammonia were maintained, they would be able to make a better contract next June. There was a healthy reduction in the amount of capital spent per million cubic feet of gas sold. Last year it was £937, against £1143 two years ago—a reduction of £206, brought about by the large development in the consumption. The quantity of gas sold was 50,492,800 cubic feet—an increase upon 1897 of 6,740,800 cubic feet, and 11,198,800 cubic feet more than in 1896. This augmented sale was equal to 15·4 per cent. on last year, and 28·5 per cent. on 1896. Mr. R. Thornton (the Vice-Chairman) seconded the motion; and remarked that the works were never in a better condition than they were now. The report, which was adopted, showed a balance of £3352 available for distribution, after paying interest on loans and preference shares, and an interim dividend for the June half year of 2½ per cent. on the original shares, and 1¾ per cent. on the new ordinary shares. It was resolved to declare a dividend for the December half year of 3¾ per cent. on the former, and 2⅝ per cent. on the latter shares. This will absorb £1055, and the balance of £2294 will be carried forward. The dividend is an increase upon 1897 of £1 5s. on the original, and 17s. 6d. per cent. on the new ordinary shares.

At the annual general meeting of the Newmarket Gas Company on Monday, the 13th inst., the Chairman (Mr. R. Stephenson), in moving the adoption of the report, noticed in the "Journal" last week, referred to the expenditure of £1409 on capital account, and said that part of this sum was for the erection of a sulphate-house. By the manufacture of sulphate of ammonia, they expected to make a profit of £100 per annum. Their receipts during the year had diminished by £15, as compared with the preceding year; but they had reduced the price of gas, and had, upon the consumption recorded, lost £366 10s. on this account. Referring to the sliding-scale in their Act, he said that under it the shareholders had benefited to the extent of £150, while the consumers had gained £366 10s. He expressed his confidence that, though the Company might lose some consumers through the establishment of the electric light works, most of those consumers would come back to them when they found how much dearer electric light was than gas. The Company could manufacture gas at 1-14th the cost of producing electric light. They had 280 customers who used slot meters, and had received £591 from them during the year. The report and accounts were adopted; and a dividend of 6½ per cent. was declared.

The half-yearly general meeting of the Newport (Mon.) Gas Company was held on Monday, the 13th inst.—Mr. E. J. Phillips presiding. In moving the adoption of the report for the six months ending Dec. 31, 1898, the Chairman stated that, unfortunately for the Company, the South Wales coal strike and the large cost of coal had added £2000 or more to the expenses. The strike had also materially reduced the consumption of gas; the tradesmen not lighting up their shops to the extent they would have done had trade been good. Another thing which had militated against them was that the winter had been comparatively warm, and people had not used gas-stoves so much as they would otherwise have done. There was one thing satisfying to the proprietors to know, and that was that, although they had made 3½ million cubic feet of gas less during the half year than in the corresponding period of 1897, and had not earned sufficient to pay their dividend, yet they had a reserve fund—money they had put by—of £13,000; and a resolution would be submitted to transfer a sum from the reserve to the profit and loss account. By this means, they would be able to pay the usual dividend, and leave a large balance in hand. Since the 1st of January this year, they had sold about 2 million cubic feet more gas than in the corresponding period of last year; so that they might really look upon the loss in the past six months as being due to exceptional circumstances. The incandescent gaslight was largely used; and by it a material saving was effected as compared with the cost of electricity. They had entered into an arrangement by which they could supply houses rented at not exceeding 10s. per week with gas-fittings and meters, either for pence, sixpences, or shillings; and they had applications for about 1000 new consumers. If the consumption went on at the present rate, he had not the least doubt that in the course of the current year the sale would be increased by 24 million cubic feet. The report was adopted. It was resolved to transfer £3000 to the profit and loss account; and the usual dividends were declared.

The report presented at the half-yearly meeting of the Scarborough Gas Company last Saturday showed that the net revenue, including £357 brought forward, and after deducting all interest charges for the six months ending Dec. 31, 1898, was £7936. After providing for dividends on the preference stock, the Directors recommended the payment of maximum dividends on all other stocks of the Company, less income-tax. This would absorb £5826, and leave a balance of £2110 to be carried forward. A large increase in the demand for gas, and an improved condition of the residuals market, were satisfactory features of the past half-year's working. The extension of the manufacturing plant, which is in progress under the supervision of Mr. J. Holliday, the Engineer and Secretary, is expected to be completed during the current six months. The quantity of coal carbonized was 13,306 tons; of cannel, 104 tons. The residuals produced were: Coke, 8046 tons; tar, 791 tons; ammoniacal liquor, 1199 tons. The quantity of gas sold to ordinary consumers was 132,041,600 cubic feet; for public lighting, 11,561,100 cubic feet—producing a revenue of £19,261. The report was adopted; and dividends at the rate of 5 per cent. per annum on the various stocks were declared.

The 104th half-yearly general meeting of the Wakefield Gas Company was held on Monday last week—Mr. W. A. Statter, J.P., in the chair. The Directors' report, noticed in the "Journal" last week, having been presented, the Chairman moved its adoption. Alderman Roberts (the Mayor) seconded the motion; and it was carried. The Chairman proposed the payment of the usual dividends of 11½, 9, and 8½ per cent. on the different classes of shares; and this was agreed to.

The annual meeting of the Walker and Wallsend Union Gas Company was held on Monday last week. The report presented showed revenue amounting to £20,933, and expenditure £15,630—leaving a balance of £5303. The report was adopted; and a dividend of £4 12s. 6d. for the half year (making, with the interim dividend, £9 5s. for the year) was declared.

At the half-yearly general meeting of the Waltham Abbey and Cheshunt Gas Company next Friday, the Directors will report a satisfactory increase, to the extent of 5·75 per cent., in the quantity of gas sold in the six months ending Dec. 31, as well as an augmentation in the receipts from residuals. In consequence of the erection of new purifiers, boilers, and washing plant, necessitated by the increasing business of the Company, the amount charged to repairs is higher than usual; but the works and distributing plant have been maintained, under the supervision of Mr. W. Bince Randall, the Engineer and Secretary, in a condition of thorough efficiency. There is a surplus of £2156 of undivided profits; and the Directors recommend a dividend on the original shares at the rate of 7 per cent. per annum, and on the "B" and "C" shares at the rate of 5 per cent. per annum.

At the ordinary general meeting of the Wellingborough Gas Company next Monday, the Directors will have the pleasure of reporting a considerable increase in the Company's business for the six months ending Dec. 31, 1898; the sale of gas having been upwards of 8½ per cent. greater than in the corresponding period of 1897. The revenue from this source was £6135; and from the sale of residuals, £1242. The total income was

£7405. The expenditure being £5196, there is a balance of £2209, as compared with £2153 this time last year. The Directors recommend a dividend of 6 per cent. on the "A" and "B" shares, and 4½ per cent. on the "C" shares, free of income-tax, for the half year. With regard to the works, which are under the supervision of Mr. J. T. Lewis, the improved settings of retorts in the new house, with charging and drawing machinery, are in use; and the completion of other apparatus in connection therewith is being proceeded with. The Directors state that considerable further alterations and extensions will be needed in the immediate future to keep the works fully equal to the increased demand for gas. In the past half year, the bulk of coal carbonized was 4202 tons. The quantity of gas made was 45,561,500 cubic feet, or 10,842 cubic feet per ton; of gas accounted for, 44,055,600 cubic feet, or 10,484 cubic feet per ton; of gas sold, 43,682,500 cubic feet, or 10,395 cubic feet per ton—the unaccounted-for gas being 3·35 per cent. The coke for sale was equal to 9 cwt. 3 qrs. 5 lbs. per ton of coal; the make of tar was 46,435 gallons, and of ammoniacal liquor 77,510 gallons.

The 55th half-yearly meeting of the Westhoughton Consumers' Gas Company was held on the 9th inst., under the presidency of Mr. W. C. Buckley. The report and accounts for the half year ending Dec. 31, 1898, were submitted and adopted. There had been expended on capital account the sum of £927 17s. 11d., principally on the new retort-house, &c. The total receipts on revenue account were £2108; the expenditure aggregating £1421—leaving a balance of £687. There was a disposable amount of £662, out of which the Directors recommended the declaration of a dividend after the rate of 5½ per cent. per annum, free of income-tax. This was agreed to. The dividend is ½ per cent. more than for the six months ending June, 1898. During the proceedings, the Chairman referred in congratulatory terms to the completion of the recent extensions in so satisfactory a manner, under the supervision of the Manager and Secretary (Mr. J. Pickup), to which reference was made in the "JOURNAL" a fortnight ago; also to the good prospects of the Company.

Water Companies.

The shareholders of the Brompton, Chatham, &c., Water Company held their half-yearly meeting on the 9th inst.—Mr. J. Baird presiding. The Secretary (Mr. G. G. Catt) read the report for the half year ending Dec. 31, 1898, which showed that the gross water-rental amounted to £11,006, or some £754 in excess of the preceding six months. A sum of £1258 had been written off for discounts, allowances, &c., to consumers; and after making provision for payment of the full statutory dividends, the balance had been found sufficient to warrant the transfer of £650 to the reserve fund. In consequence of the development of building estates, some 1893 yards of mains were laid during the half year, with 281 additional services attached, from which there will be an increased rental of about £232 per annum. The maximum dividends, at the rate of 10 per cent. per annum on the "A" shares, and (from their respective dates of issue) 7 per cent. per annum on the new "B" shares, free of income-tax, were recommended. The report was adopted.

Mr. W. C. Pendarves, J.P., presided at the 63rd half-yearly meeting of the Camborne Water Company on the 10th inst.; and in moving the adoption of the report, he said the dividend was smaller than last time—9 per cent. on the "A" shares, and £6 6s. on the "B" shares. The past half year had been a somewhat expensive one, otherwise they would have been able to declare a dividend similar to that which they had paid on previous occasions—viz., 10 per cent., the full amount allowed by the Act. Owing to the very dry summer, it had been necessary to incur a considerable amount of extra expense; and the Directors thought it right to make a contribution towards the unusual cost the Local Authority were put to on account of the outbreak of typhoid fever. The total receipts for the half year were £1240—£49 more than in any previous six months, and £76 more than for the corresponding period of 1897. The arrears were £18 less. Mr. H. R. Vivian seconded the motion; and it was carried.

The shareholders of the Colne Valley Water Company, at their meeting last Tuesday, were congratulated by the Chairman, Mr. J. R. Holland, on the striking progress of their business during the past six months. In that period, he said, the water-rates amounted to £10,303, as compared with £9388 in the corresponding six months of 1897; being an advance of £915. The increase in the June half was £761; so that the entire year showed an advance of £1676. The increase in 1897 over 1896 was £1233, which was the largest gain they had had in a year during the history of the Company. The number of new supplies in the half year ending June was 205; and in the six months ending Dec. 31, 346—giving a total of 551, and an estimated rental of £1233 per annum. As an indication of the excellent prospects of the Company, he referred to the vigorous manner in which building was being carried on in the district, as evidenced by the growth of the receipts for building supplies, which in the past five years showed a substantial annual increase. In 1893, they amounted to £287, and in 1898 to £810. Commenting upon the expenditure, he pointed out that on repairs to the pipe system £100 more had had to be spent, owing to the heat of the soil during the summer and autumn months causing an exceptional amount of breakage in the smaller mains. The total expenditure was only 39 per cent. of the gross income, which contrasted very favourably with other water companies. Regarding the consumption of water, it amounted to 266 million gallons in the half year, as against 260 millions in the December half of 1897. The quantity consumed during the whole year was 486 million gallons, as compared with 488 millions in 1897, which was a decrease, notwithstanding the larger number of houses now supplied. He attributed this to the system of waste prevention which they had adopted, and which had amply repaid them. The consumption for domestic purposes was about 23·50 gallons per head per day. It would, he also remarked, have been possible to have paid a slightly increased dividend on this occasion; but it seemed desirable to the Directors to clear off more of the old engine suspense account. They had therefore written off a further £750, and added an additional £100 to the reserve account. Speaking of the works, he mentioned that good progress was being made with a new service reservoir, which was commenced in August last. He concluded by moving the adoption of the report and accounts. Mr. C. E. Keyser seconded; mentioning that this was the jubilee meeting of the Company. Mr. Hepburn, referring to the drought of last year, congratulated the Directors upon the fact that the wells in their immediate neighbourhood had done so much better than those on the Lea Valley side of Hertfordshire. The motion was carried. A dividend at the rate of 5 per cent. per annum was then declared; and the retiring Directors and Auditors were re-elected.

At the general meeting of the Cranbrook District Water Company on the 7th inst., the Chairman (Mr. S. R. Dennis) stated that since the opening of the works in August the Company had practically laid 4½ miles of 9-inch mains. These took in the village of Goudhurst, with a population of about 2000 persons; and they had also proceeded with the extension to Tenterden—a place rather more populous, containing about 3500 persons. On the way to Tenterden they took in Benenden and Rolvenden; so that since the works were opened they had practically laid on water in excess of that supplied. These extensions were therefore very satisfactory, and likely to be extremely profitable to the Company. The report and balance-sheet were adopted.

An ordinary general meeting of the Felixstowe and Walton Water Company was held last Tuesday—Mr. W. Jolley presiding. The report of the Directors stated that the balance standing to the credit of the dividend and interest account amounted to £1411; and it was recommended that a dividend of £4 12s. 6d. per cent. be paid for the past year on the original share capital, and £4 6s. 4d. per cent. on the additional share capital. The Felixstowe and Walton Urban District Council last session obtained an Act of Parliament granting them powers to purchase the undertaking of the Company; and in May last the Council gave notice to treat. The Company consulted Mr. James Mansergh, with a view to ascertain the value of their undertaking and the amount they would be entitled to receive; but up to the present nothing definite had been decided by the Council. The report was adopted; and the dividends recommended were declared.

General Sir G. W. A. Higginson presided at the recent annual meeting of the Marlow Water Company, when the report and accounts were presented. The former stated that, despite the increase in the expenditure caused by the very dry summer, an additional profit of £67 had been made over that for 1897; the receipts from water-rentals having gone up from £1285 to £1447. The amount to the credit of the profit and loss account was £1177; and the payment of a dividend at the rate of 5½ per cent. on the original shares, and £3 17s. per cent. on the additional shares was recommended, leaving £622 to be carried forward. The report was adopted after some discussion.

At the annual meeting of the Newcastle and Gateshead Water Company next Tuesday, the Directors will report a satisfactory increase in the water revenue, counterbalanced, however, by a considerably greater expenditure, especially for pumping. The gross receipts for the year ending the 1st of February were £139,491. After deducting working expenses, interest on debenture stock and loans, and the interim dividend paid in August last, there remains a balance of £47,742, which the Directors recommend to be appropriated as follows: To the payment of dividend on the preference stock, £16,331; dividend after the rate of 9 per cent. per annum for the past half year on the ordinary stock, making 8¼ per cent. for the year, £17,477; dividend after the rate of £6 6s. per cent. per annum for the half year on the ordinary stock under the Act of 1876, making £5 15s. 6d. per cent. for the year, £10,080—leaving £3854 to be carried forward. Notwithstanding the long and continuous drought of last summer, a full and unrestricted supply of water was maintained throughout the Company's district. The reservoirs are now, and have been for some time, overflowing; and the Company are therefore in a favourable position to face the coming season.

The half-year's working of the Stockport Water Company produced a profit of £8545, after paying interest on the debentures, amounting to £1125. With the sum brought forward, there was a balance in hand of £10,026, out of which the shareholders yesterday week decided to pay a dividend at the rate of 7 per cent. per annum.

At the annual meeting of the Sunderland and South Shields Water Company next Thursday, the Directors will have pleasure in reporting a substantial increase in the revenue from water-rents, which amounted to £82,919 for the past year. After deducting the considerable increase in the cost of coal and other materials and labour, there is a balance of £38,638; and a balance on the profit and loss account of £47,449, enabling them to meet the additional interest on money borrowed and dividends on the new stock sold. They will recommend that a dividend be declared for the six months ending Dec. 31, 1898, at the rate of 4½ per cent. on the ordinary and preference stocks, of £3 3s. per cent. on the additional capital stock (7 per cent.), and of £2 5s. per cent. on the new (5 per cent. maximum) stock of the Company; making, with the interim dividend paid in September last, 9 per cent. on the ordinary and preference stocks, £6 6s. per cent. on the additional stock, and £4 10s. per cent. on the new stock for the year, free of income-tax.

Horsforth Water Company's New Works Scheme.—The Horsforth Water Company have deposited, for the information of Parliament, an estimate of the cost of the proposed works which are sought to be constructed under the Bill which they are promoting in the present session. It amounts to £27,000; and to meet the expenditure it is proposed to create £30,000 of additional share capital.

Bude and Stratton Water Supply.—A definite step has at length been taken towards providing a supply of water for Bude and Stratton. A meeting of the Bude Harbour and Canal Company was held yesterday week at Exeter, when the provisional agreement for the sale of the undertaking to the Stratton Rural District Council was confirmed. The Company are to receive £8000 for their undertaking other than money in hand and debts due, subject to the Council obtaining an Act of Parliament authorizing the transfer. Pending this, the Council may construct works for utilizing water from the reservoir, and pay the Company at the rate of 3d. per 1000 gallons for the first 10 million gallons per annum, 2d. per 1000 gallons for the second 10 million gallons, and 1d. per 1000 gallons for any additional quantity. The price will yield the shareholders in the canal from £4 to £4 10s. per share; and the Directors, in strongly recommending the adoption of the agreement, expressed their opinion that the terms were more favourable than they were likely to obtain under any other circumstances. The Bude Canal was constructed in 1819 for the purpose of affording water communication in West Devon and North Cornwall. The water is obtained from the River Tamar, and is stored in a reservoir some 70 acres in extent situated 800 feet above the level of the lower end of the canal.

THE LONDON COUNTY COUNCIL AND GAS AND WATER SUPPLY.

At the Meeting of the London County Council last Tuesday, Mr. Westacott moved—"That application be made to the Board of Trade to hold an inquiry into the present management and working of The Gaslight and Coke Company, with a view to ascertaining whether there is any reason why the gas supplied to consumers north of the Thames should be charged at a higher rate than that supplied to consumers on the south side, and whether measures can be taken to secure a uniform rate of charge for all gas supplied in London." He said he saw no reason why in North London they should have to pay 3s. per 1000 cubic feet for gas, when in South London the supplying Company made a profit by selling it at 2s. 2d. An important fact was that The Gaslight and Coke Company only charged their South London customers 2s. 2d. The motion was agreed to. The Water Committee recommended that the Chemist be authorized to incur an expenditure not exceeding £29 a week, for a period of three months from the 1st inst., in making six complete examinations weekly of the water supplied by each of the Metropolitan Water Companies. The recommendation was agreed to, but not without protests from Mr. Campbell and Colonel Ford, on the ground that the proposal meant a sheer waste of public money, in view of the thorough examination to which the water is now submitted. At the same meeting, Mr. Parker moved that it be referred to the Rivers Committee to consider as to instructing the Engineer and an expert to report upon the desirability of constructing water-wheels or the fixing of floating turbines at the various bridges, or the making of reservoirs, and generally upon the best method of utilizing the tides on the River Thames for the purpose of motive power adaptable to the generation of electricity. In proposing the resolution, the speaker expressed the opinion that the adoption of the suggestion might result in some good. The motion was seconded by Mr. Thornton; but the Council were not impressed with either the practicability or the advisability of the proposal, for they declined to adopt it.

THE SOUTHPORT CORPORATION GAS UNDERTAKING.

Mr. Corbet Woodall's Report.

At the Meeting of the Southport Town Council last Tuesday, there was a discussion—somewhat acrimonious in tone—on the report of Mr. Corbet Woodall upon the gas undertaking (see *ante*, p. 134).

Alderman GRIFFITHS, in moving the adoption of the Gas Committee's minutes, said it was quite unnecessary for him to go into Mr. Woodall's report. Every member of the Council had probably read it; and really there was nothing which required immediate attention. In regard to the accounts, they had decided to make some improvement in them; and as to the re-arrangement of the retorts, this was a question which might stand over for some years yet. They did not need to expend large sums of money on capital account for a considerable time.

Mr. DIMOND seconded.

Alderman FISHER said he need not remind the Council that the management and the Committee had been censured by a large section of the Council very many times. The Committee, it was insinuated, knew nothing about the gas-works; and other Corporations and gas-works were held up as models for them to follow, both as regarded the quality and cost of gas production. This led to the engagement of an expert. Like a certain prophet, he was expected to curse; and he had blessed. [MEMBERS: Not altogether.] With the exception of the portion of the report relating to the setting of the retorts, about which there might be a difference of opinion, Mr. Woodall did not say a word against the works. His only adverse opinion was that they charged more to revenue than they should have done, and that more should have gone to capital. He himself did not think they need be ashamed of that position, as it was not always wise to increase the capital account if they could help it. He expected the ratepayers, after this evidence, would be prepared to give to the Committee credit for having done what they could in the management of the undertaking for the benefit of the town. He for one was quite satisfied with the report.

Mr. HOLLAND was surprised that, knowing what Alderman Fisher did of the past history of the estate, he should get up and try to defend it in the manner he had done. He did not want to "reap up old scores;" but if he did, he could say some very strange things, which would not be creditable to the gas undertaking or anyone connected with it—if they knew what was going on at the time.

Protests were made against imputations being cast on the management in this way without the facts being given.

Mr. HOLLAND (proceeding) admitted that improvements had been made in the working during the last four or five months; but in reference to a saving of 3d. per 1000 cubic feet which Mr. Woodall referred to, he said this was to be obtained by setting to work the carburetted water-gas plant. He for one would emphatically oppose this, as there were other experts who said that water gas was unfit for use.

It was pointed out by Alderman Rimmer that Mr. Holland had not attempted to justify his accusation against the management; and on the advice of the Mayor, Mr. Holland withdrew his statement, but apparently in a very reluctant manner.

Dr. WEAVER said that as the mover of the resolution by which Mr. Woodall was appointed, he supposed he ought to feel frightened and sorry for the action he took; but, on the contrary, he was very glad. As far as the report itself went, he could not say he thought very much of it. It threw out hints as to what they might do in the future, which might be valuable; but it was surprising to him that on the very points on which they had improved the gas estate, Mr. Woodall did not say a word.

Mr. HESFORD said there were certain omissions in the report which struck him. The first was the absence of any statement with regard to the oil plant. He wished to emphatically state that the Committee would have been wise to have seen Mr. Woodall, and given him definite instructions on certain points which he had not touched. He had supposed that the Committee would have taken some pains to study the report, and endorse it where possible; but in his perusal of the minutes he had failed to find any decision on the matter. The question he put before the Committee was: Do you, given the capital to do it, produce gas as cheap as other people? In this instance he said they did not, and had not done. He found from the Board of Trade returns that, in the average output of 212 local authorities, including their own, Southport was beaten by 600 cubic feet. Thirteen different tests had been made with their own material; and the average production of gas was 10,600 cubic feet. His firm opinion was that they were now showing an improvement, and that it was owing to the increased cost per ton of material used.

Alderman GRIFFITHS protested against the line of argument which had been used. It was neither fair nor just. He wanted them to accept the report as a true one. They had in their possession works which were well in advance of present requirements with the exception of the matter of storage. The works were well designed, well kept, and were a credit to the town. There was one recommendation which was in the far future—viz., the building of inclined retorts. There were only two ways in which they could affect the cost of production. One was in the cost of material, and the other in the cost of labour. If they adopted mechanical appliances, they could save 40 per cent. in the cost; but it would be in labour only. But what was accomplished where they had the newest appliances? Taking seven towns using inclined retorts, not one of them showed so good a return as their own; and this was due to the work of their much-maligned Manager. He hoped that unkind criticism would not be used in the future.

The minutes were then adopted.

GOOD MANAGEMENT AT THE WIDNES GAS-WORKS.

Increase in Mr. Isaac Carr's Salary.

The Widnes Town Council were occupied for some time last Tuesday in considering the minutes of the Gas and Water Committee, which contained a resolution to raise the salary of Mr. Isaac Carr, the Gas and Water Engineer, by £150 per annum. The Chairman of the Committee (Alderman Timmis), in moving the confirmation of the minutes, remarked that when, in June last, a recommendation was submitted to increase the salary of the Engineer by £100 per annum, he laid before the Council a number of figures constituting the basis of the suggestion. These figures went down to the end of the year 1897-8. Since then another twelve months had almost elapsed; and as it had been a period of progress, the Committee felt justified in recommending an additional £50. The Gas Department, owing to the stoppage of works, received a severe check at the commencement of the current year. But the low price at which gas was being sold had led to further increased consumption, as was anticipated; and this, together with the continued extension of the prepayment meter system, had more than made up for the falling off in the consumption, and at the present time they had an increase, as compared with last year, which for a number of weeks past had averaged 10 per cent. If the Corporation were to sell gas at the prices charged by their neighbours—2s. 8d. and 3s. per 1000 cubic feet—the gas consumers of Widnes would be paying £15,000 per annum more for gas than they were now doing; or, in other words, the saving to the gas consumers was equal to a rate of 2s. 4d. in the pound. These benefits were received by the ratepayers generally, because practically the whole of the ratepayers were gas consumers; the number of consumers approximating more to a town of 100,000 than to one the size of Widnes. Then again, it was common practice almost throughout the country, with the exception of very large towns, for Consulting Engineers to be called in when extensions became necessary. Mr. Carr, however, had not only designed the buildings and plant of the extensions, but had carried out the greater part of the work with the Corporation's own men, and this at an exceedingly low cost. The aggregate capital on the present make of 202 million cubic feet per annum stood at only 7s. per 1000 cubic feet; and when the works were making up to their full capacity, this figure would be about 4s.—thus proving the low cost at which the extensions had been carried out. These figures compared most favourably with those of other corporation gas-works, where in one case the capital charges amounted to as much as 17s. 3d. per 1000 cubic feet, and sometimes more. Last year, when he dealt with their work up to March, 1898, he pointed out that they had paid more for coal and had had various difficulties to deal with, but he did not anticipate any this year. When the year 1898-9 began to draw to a close, knowing what happened during the year, he must say he was very much astonished and pleased at the results, which were almost marvellous; and with these before him at the Committee meeting, he proposed that a further increase should be given to Mr. Carr. Although there had been an increase in the cost of coals of £250, together with an increase of £150 in the maintenance of the mains, £176 for public lighting, £153 in standing charges, &c., and a falling off in revenue of £1350, due to the last reduction in price, making a total of about £2200, the cost of manufacture and maintenance had been reduced by 2·7d., or to 5d. per 1000 cubic feet. This included an increase of about £1000 from the larger quantity and better prices obtained for coke and sulphate of ammonia; and it was estimated that the profit for the present year would amount to about £2440, or £4100 if credit were taken for the cost of public lighting. Of course, as he said, this was due to management; and the management had a right to be rewarded. The estimated profit would allow them to make a further reduction of 2d. per 1000 cubic feet in the price of gas; thus bringing the figures down to 1s. 2d. and 1s. 4d., which would absorb £1600. But he thought this was hardly a question of present politics; and he proposed to pass it over. If it were done, it would mean that the cost to the consumer would be 1s. per 1000 cubic feet—a figure which had never been approached in gas making. Many gas engineers had dreamt of it, but few had ever thought of getting it, although they in Widnes had accomplished it. Comparing with Widnes towns similarly situated in regard to coal, and supplying gas of similar illuminating power, their average cost of manufacture and maintenance was 5½d. per 1000 cubic feet more than at Widnes, which amounted to £4550 on the present make, compared with the working for the year ending March, 1898. If the comparison with other works were made with the estimate of the present year's working, the difference would be 7·95d. per 1000 cubic feet, amounting to £6890; but as 0·83d. per 1000 cubic feet of this year's increase was due to the increased value of the residual products, it was only fair to assume that other works would have had the same advantage, and their cost of production have been reduced

accordingly. Therefore the figure for comparison should include only the amount of economies effected in working at Widnes, which this year was 1·87d. per 1000 cubic feet over that of last year; making a total for this year's working of £1620. Their Engineer was a man who was always trying to go forward—a man of energy who desired to improve and take care of their interests; and the work he had done justified the arguments he (Alderman Timmis) had advanced in support of the Committee's recommendation. Mr. Davies seconded the motion, which, after some discussion, was carried by 14 votes to 9.

THE BRISTOL CORPORATION AND THE GAS COMPANY'S BILL

A Committee of the Bristol Corporation have presented a report on the Bill promoted by the Bristol Gas Company to obtain authority to erect works, to raise additional capital, and for other purposes (*ante*, p. 125). With regard to capital, the proposal is to increase the stock from £1,022,500 to £1,322,500, and the loans from £255,625 to £355,625. The Committee express the opinion that it is very questionable indeed whether so large an increase of the capital powers of the Company is necessary at the present time; and they consider that, in any case, no money to be obtained by borrowing should be raised by mortgage, but by the issue of debenture stock, subject to the auction clauses. The proposed powers to lay pipes and culverts in streets for the purpose of disposing of residuals, or for any purpose connected with the Company's undertaking, appear to the Committee to be most objectionable; but if granted they should in every case, it is urged, be subject to the consent of the Council, and to such limitations and conditions as they may impose. The clause empowering the Company to supply motors and dynamos should, in the opinion of the Committee, be strenuously resisted, as it would enable the Company, while preserving their own monopoly for the supply of gas, to compete with the Corporation in the supply of electricity; and not only so, but the proposal to repeal the provisions of the Act of 1853, requiring them to supply gas to the public lamps at a figure equal to the lowest price charged to a private consumer, would enable them to sell gas for the purpose of generating electricity at a low price, to the detriment of the consumers of gas for lighting purposes. The clauses as to notice to the Company by consumers quitting their premises, and for the alteration of pipes and fittings, should, in the opinion of the Committee, be amended so as to render a consumer only liable for the supply of gas before notice is given to the Company; and the alteration of any pipes and fittings constructed or fixed in accordance with the practice formerly adopted with the concurrence of the Company should be made at their expense. Further, the clause providing that when a meter is found to be erroneous the error is to be deemed to have arisen during the preceding quarter, should be amended by the substitution of the word "current" for "preceding." The Committee consider that the Bill should, in addition to other matters, provide that the obligation which the Company are under with reference to the area included in the city prior to its recent extensions should be extended to the whole of the existing city. They recommend that a petition should be presented against the Bill.

THE OPPOSITION TO THE YEADON AND GUISELEY GAS BILL.

A conference of representatives of the District Councils of Yeadon, Rawdon, and Guiseley and the Menston Parish Council was held last Monday week, for the purpose of considering a letter which had been received from Messrs. Watson, Son, and Smith, Solicitors to the Yeadon and Guiseley Gas Company, suggesting that an interview take place between them and the Clerks to the various Councils for the purpose of ascertaining what were the points in the Company's Bill objected to, and whether these could not be met in a manner satisfactory to both parties, without the expense of opposition. Mr. J. W. Pratt (Rawdon) proposed that opposition to the Bill be withdrawn, so far as regards the gas clauses, if the Company would substitute the net price of 2s. 8½d. per 1000 cubic feet now charged for the standard price of 3s. 6d.; such compromise to be subject to the approval of the ratepayers. The proposition was carried on the casting vote of the Chairman. It was further decided to ask the Company to withdraw the electric lighting clauses from their Bill. At a special meeting of the Yeadon Council on Wednesday, the Company's Solicitors' reply was read. They found it impossible to meet the consumers by fixing the standard price at lower than 3s. 6d., but thought the proper way was to provide that any benefits which might accrue to the Company under the Act should not be received by them if a higher net price than was agreed upon should be charged. A draft clause setting forth this proposal in legal phraseology was enclosed. The reply was considered by the Council to be unsatisfactory; but no decision was arrived at pending the ratepayers' meeting to be held in the evening. Subsequently a meeting of owners and ratepayers took place in the Town Hall—Mr. Thompson Marshall (the Chairman of the District Council) presiding. The Chairman explained that the Company declined to fix the standard price at 2s. 8½d. per 1000 cubic feet, or to withdraw from their Bill the electric lighting clauses. He proposed a resolution authorizing the Council to oppose the Bill, and to charge the cost on the district rates. Dr. Usher raised an objection to the wording of the statutory notice convening the meeting, contending that it was not in proper form. The Chairman ruled that the notice was in order, and said the Council would take the consequences. A lively discussion ensued; and eventually the resolution was carried with but one dissentient. Dr. Usher, amid great disorder, demanded a poll on the question. At meetings of ratepayers held in Rawdon and Guiseley, opposition to the Bill has been sanctioned.

Sales of Shares.—Last Thursday, Mr. S. Johnson sold £150 of consolidated "A" stock of the Elsecar, Wentworth, and Hoyland Gas Company for £260, £135 for £247, and £50 for £90. Some £10 shares (£9 paid) fetched from £16 to £16 8s. each. On Friday, Messrs. Darby and Co. disposed of five original £25 shares in the Chelmsford Gas Company at £49 each. Three £25 shares (additional capital), fully paid, in the same Company realized £35 10s. apiece.

ELECTRIC LIGHTING NOTES.

The Bury St. Edmunds Town Council have accepted tenders amounting to £15,250 for the construction of their electric lighting works.

The Electric Lighting Committee of the Hampstead Vestry report an increase of 41 per cent. in their consumers' accounts for the three months ending Dec. 31 last—£8312, as against £5892 for the corresponding quarter of 1897.

The Margam District Council resolved, at their meeting last week, to light part of the district with electricity at a cost of £6500. This will provide 1000 lamps; and it is anticipated that the capital will be repaid, with interest, in 25 years.

The Electric Lighting Committee of the Swansea Corporation yesterday week adopted a recommendation of a Sub-Committee that an amended application be made to the Local Government Board for sanction to raise a loan of £54,648 for electric lighting purposes.

The electric lighting undertaking at Walsall is not at present a financial success. The Electric Lighting Committee reported to the Town Council yesterday week that the loss on their operations last year amounted to £279 3s. 11d., and that the number of consumers now supplied is 139.

On Monday and Thursday last week, explosions occurred in an electric lighting culvert in Ann Street, Belfast, and violently dislodged the heavy flagstones of the pavement, and also the covers of the culvert boxes. The disturbance caused by the explosion on Thursday spread over the footpath for some 30 or 40 feet distance. It is supposed that escaping gas had found an entrance into the culvert.

A gradual progress continues to mark the business of the Newcastle Electric Lighting Company. The installations connected to the Company's system during the past year were equal to 3678 10-candle power lamps; bringing the total up to about 36,278 lamps. The electrical energy supplied amounted to 778,828 units, as against 642,969 units in 1897. An interim dividend of 3½ per cent. was paid; and a further 5 per cent. was declared at the meeting of the shareholders last Tuesday.

Once again the question of lighting St. Paul's Cathedral by electricity is being discussed; and it is announced that the Authorities have now obtained the money required for the installation—about £5000. It appears that there is a division of opinion as to the suitability of the building for electric light, and especially as to the disposal of the lights. The incandescent gas system has been on trial in the Cathedral, with very good effect; and one may ask: Why not continue and extend it?

Kingswood, near Bristol, is in the unfortunate position of being without any street lighting at night, in consequence of the electric light having been suddenly cut off. The explanation appears to be that the District Council agreed some time since to purchase the electric light works for £1250; and this they now refuse to do. As a result, the mortgagees of the Syndicate who have been running the installation have entered into possession of the property, and stopped the supply of current. A writ has also been issued against the Council for damages for breach of contract.

Mr. G. W. Willcocks held an inquiry last Wednesday at Wolverhampton, into an application by the Town Council to the Local Government Board for sanction to borrow £29,740 for the purposes of electric lighting. After explaining in detail the present system, the Town Clerk informed the Inspector that the maximum demand during the present winter was on Dec. 21, and amounted to 420 kilowatts, representing practically 90 per cent. of the total available capacity. The maximum demand for private lighting on the transformers was 300 kilowatts; representing about 95 per cent. of the total capacity. The number of consumers was 270; and the quantity of units supplied for the year ended March 31, 1898, was 291,233. If there was an increase in the same ratio in the ensuing year, the present plant would be entirely inadequate to meet the demand. It was further proposed to extend the supply, and to make improvements in the distribution system.

OPENING OF MESSRS. FLETCHER, RUSSELL, AND CO.'S NEW WORKS AT WARRINGTON.

Last Wednesday, Messrs. Fletcher, Russell, and Co., Limited, formally opened the new works they have erected at Warrington, which will not only largely increase their means of production, but will effect an important change in the general arrangement of their combined businesses of manufacturers of gas appliances and producers of various descriptions of ornamental castings. Hitherto the bulk of the castings for the gas stoves, cookers, &c., have been made at the Pendleton foundries. The entire manufacture of gas appliances will now be concentrated in the new Warrington works, and those at Pendleton will be devoted mainly to the manufacture of ranges, mantles, lavatories, and general light castings. The electro-plating, bronzing, and enamelling processes will also still be carried on at Pendleton, where, it may be mentioned the Company are now making a feature of a special enamel suitable for gas-stoves and other goods, which will stand the greatest possible heat without either cracking or discoloration.

The new works at Warrington, which have been laid out on the most modern lines, and, with the exception of the grinding-shop, are to be driven throughout by electric power (the same means being also adopted for lighting), are situated between the Wilderspool Causeway and the low-level siding of the London and North-Western Railway Company. They consist of a fine range of buildings covering something like five acres; an additional eight acres having been acquired which will be available for further extensions. The main entrance occupies the centre of a handsome building in brick and stone fronting to Wilderspool Road, and consisting, on the ground floor, of the time office, the inwards goods and stores departments, dining-rooms for the workmen, and temporary iron pattern stores. On the first floor are the offices and board-room, &c.; and on the second floor, large show-rooms. Entering the works, a large three-storey building, with spacious cellars and attic, is first approached. This contains the warehouse and despatch departments; and an electrically-driven hoist conveys the goods from floor to floor. Running alongside the southern part of the building is the loading-stage and shed, in direct connection with a double-line siding communicating with the London and North-Western Railway, where goods are placed upon the railway trucks ready for dispatch. On the south side of the warehouse department is the boiler-house, opposite which and immediately adjoining

the warehouse, are two one-storey buildings, consisting of the burner, gas-oven, and gas-fire testing departments; while under the same roof are the blacking-shop and store. Adjoining are the grinding and polishing departments. The engine-house contains a compound tandem engine indicating about 130-horse power; and from the main countershaft are driven two generating dynamos—one for distributing electric power to the various departments, and the other for the electric lighting of the works. On the left hand, or north side, is another block of buildings, two storeys in height, with commodious attics, containing, on the ground floor, the fitting-shop and the heavy machinery for stamping, drilling, &c.; and on the second floor the light drilling, fitting, and tinsmith's departments. All the machinery in these shops is worked by belt power from main shafts driven by electric motors; the same power driving the hoist for conveying goods from floor to floor. Near the western side of this block is the smithy and box-fitting department. Leaving the smithy, the stocktaker's department is entered. In a line, is the dressing department, where the castings are cleaned; while adjoining is the machine dressing department, provided with rumbling barrels and emery wheels, and a fan for extracting the dust from the various machines. Under the same roof, at one end, is the blower-room, containing the blower, driven by two electric motors, from which the air-blast is driven into two cupolas, each capable of melting 30 tons per day. Around the cupolas are erected the cupola stages and roofs, about 90 feet long, and 25 feet broad, provided with all the most modern appliances necessary for the production of light iron castings. The moulding-shops occupy the remaining portion of this building, and have an area of about 2400 square yards. These shops are well lighted from the roof, and also by electricity, with special arrangements for ventilation; and the entire floor is laid with brick and cement.

The general plan of the new works has been so carried out as to afford every facility for the economical and quick handling of the castings in the various departments, which are heated by steam, and, as already stated, electrically lighted throughout; while covered gangways connect the various buildings. Some portions of the works are not yet completed; but very shortly they will be in full operation, and will then be second to none of a similar kind in the United Kingdom. The Thynne Street establishment, it may be added, is being completely removed to the new works, where at present some 350 to 400 men are engaged; but this number will be increased to about 600 hands when the whole of the shops are fully running.

The formal opening of the works on Wednesday was made the occasion for providing an entertainment in the shape of light refreshments to Messrs. Fletcher, Russell, and Co.'s own staff of workmen and to the Contractors' employees; while there were also present a number of invited guests, for whom luncheon was served. The opening ceremony consisted in making the first castings from the furnaces. The blower was started by Mr. W. R. Neil at five minutes to two, the first iron coming down about 25 minutes later. The ceremony of tapping the first metal was also performed by him; and the first mould was filled with molten metal by Mr. A. White, the foreman moulder. Two very successful castings—one an ornamental teapot stand, and the other a gas-oven top—were produced; and the interesting ceremony having been photographed, the works were, amid loud cheers, declared to have commenced operations under most satisfactory auspices.

Reductions in Price.—As from the beginning of the year, the price of gas at Aldershot has been reduced to 2s. 6d. per 1000 cubic feet; and in Londonderry from 3s. 6d. to 3s. 3d. per 1000 cubic feet. The Directors of the Chelmsford Gas Company will reduce the price of gas as from June 30 next from 4s. to 3s. 9d. per 1000 cubic feet.

The Large Water Consumers of Stockton and Middlesbrough.—It was reported to the Stockton and Middlesbrough Water Board yesterday week that the large consumers have consented to accept the terms suggested at a meeting with various members of the Board, by which it was agreed that, if the Bill now in Parliament received Royal Assent, 3½d per 1000 gallons should be charged to consumers of not less than 5 million gallons per quarter, to be payable for twelve years, provided that on or before Aug. 13, 1900, contracts for the construction of the Grassholme reservoir and the Longnewton service reservoir had been sealed by the Board, failing which the charge was to revert to 3d. per 1000 gallons.

The Smethwick Gas Undertaking.—At the monthly meeting of the Smethwick District Council last Tuesday, the Gas Committee reported, with reference to the petition of the gas workmen for a re-arrangement of their work and wages, that the Sub-Committee, having discussed the matter with the men, recommended certain alterations which met with the approval of the men; and the Committee had adopted the recommendation. The increase in the wages account caused thereby would be about £333 per annum. The Chairman of the Committee (Mr. J. Stones) remarked that, though there had not been any foggy weather, and the demand for gas was not so great last year as before, they made a profit of £3979; being an increase of £941 as compared with 1897. The sales of gas had also gone up by about 7 per cent. It was proposed to again contribute £2000 out of the profits for the relief of the district rates. The report, which was considered very satisfactory, was adopted.

The Hastings Gas Company's Bill.—A special meeting of the Hastings and St. Leonards Gas Company was held on the 9th inst.—Dr. Gray presiding—to consider the Company's proposed application to Parliament for further powers. The Chairman moved a resolution formally assenting to the Bill. In so doing, he said the Bill consisted of a preamble, 55 clauses, and two schedules. The preamble gave the history of the Company, and a summary of the provisions for which they were applying. It also contained a clause enabling them to complete the provisional agreement for the purchase of about 14 acres of land at Glynde Gap, and also not more than 9 acres for the general purposes of the Company should it become necessary. Exception had been taken to this matter on the ground that the Corporation were going to suffer, because if the works were removed coal dues would not have to be paid. He did not think there was much in this objection to gain favour in Parliament. It would be impossible, he pointed out, to move the works in a day. Such a change must be a gradual process. Moreover, if the works were removed, the present site would be available for building purposes, and thus create additional rateable value. The motion was carried.

METROPOLITAN WATER SUPPLY COMMISSION.

Fifty-First Day—Monday, Feb. 13.

(*Viscount* Llandaff, *Chairman*, *Sir* John E. Dorington, Bart., M.P., *Sir* G. B. Bruce, M.Inst.C.E., *Major-General* A. de Courcy Scott, R.E., *Mr.* A. de Bock Porter, C.B., *Mr.* H. W. Cripps, Q.C., and *Mr.* R. Lewis.)

The Commission sat at the Guildhall, Westminster.

The following are the Counsel engaged: Mr. Pope, Q.C., and Mr. Claude Baggallay, Q.C., for the New River and the Southwark and Vauxhall Water Companies; Mr. Littler, Q.C., and Mr. Lewis Coward for the Kent Water Company; Mr. Pember, Q.C., for the Lambeth, East London, Grand Junction, and West Middlesex Water Companies; Mr. Rickards for the Chelsea Water Company; Lord R. Cecil for the Hertfordshire County Council; Sir Joseph Leese, Q.C., M.P., for the Kent County Council and Kent Local Authorities; Mr. Balfour Browne, Q.C., and Mr. Freeman, Q.C., for the London County Council; Sir R. Nicholson for the Middlesex County Council; and Mr. Gabriel P. Goldney (Remembrancer) for the Corporation of the City of London.

Mr. *J. W. Restler*, Engineer to the Southwark and Vauxhall Water Company, said the area of the Company's district was 50½ square miles, with an estimated population supplied in 1898 of 819,901. The West Middlesex, Lambeth, and Kent Companies had power to supply in the Southwark and Vauxhall Company's district; and four-fifths of the Company's area was within the Lambeth Company's district. He knew of no instance since 1852 in which pipes of two Companies had been laid side by side in the same street. There had been no competition between the Southwark and Vauxhall Company and any other Company since that date, though in some cases the two Companies were supplying adjoining houses in the same streets.

The Chairman: You do not know whether the Lambeth Company make any difference in their charges in those streets in which they are supplying alongside you?

Witness: Yes. I think the Lambeth rates and ours are the same in the joint districts.

They have been reduced to your level?—Yes.

Then competition has reduced their charges where they have come in contact with you?—Yes. By joint district I mean the streets in which the pipes of both Companies are actually laid. Section 23 of the Southwark and Vauxhall Act of 1884 authorized the Company to enter into agreements against competition with other Companies. At the present moment the parish of Battersea is divided between the Southwark and Vauxhall and the Lambeth Companies. The complaints in the district are very few; the average last year being 1·71 per day over the entire district. There was only one complaint during the whole year as to quality. They were practically all of short supply. The Company's supply, as a fact, was not short; the vast majority of the complaints being due to defective fittings.

I think it was in your system that the instance was given us of 16,000 bacteria being found in a cubic centimetre?—Yes. It occurred on Dec. 8, 1896. Directly it was discovered Dr. Frankland wrote, and a filter which had just been put to work was stopped. The sand was opened up, and a careful examination made; but nothing was discovered to explain it. The filter was started again, and has worked satisfactorily since.

It is a little alarming to hear of 16,000 bacteria in a cubic centimetre, and no explanation?—Yes. We made every effort to trace it. The only question that was raised was whether the assistant, in taking the samples, might not have confused them.

Major-General Scott: Do you consider it would be a good addition to your filters to have a means of gauging the velocity of filtration—ascertaining it by means of an indicator?

Witness: I do think so. I think it most desirable; and to show how sincere I am in the belief, I have already an apparatus suspended to our No. 2 filter at Hampton. It is being tried now with a view to being applied to every filter we have. In addition to the person in charge being able to see the rate, I think it should be recorded on a diagram. The apparatus will be working in a very few days. If the results are what I hope, it should be compulsory on all the Companies to use the apparatus.

Further examined by the Chairman: The proposal to divide the works of the Southwark and Vauxhall Company between London and Surrey was based on a 12-inch main between Hampton and Richmond, which, as a fact, did not exist. Of the two mains of the Company, neither could be employed for the separate use of Surrey without considerable loss. The requirement of Surrey was only 2 million gallons a day, and the carrying capacity of the smaller of the two mains was 8 million gallons daily; so that 6 million gallons capacity would be wasted. He did not think it would be possible to separate the inlet works between Surrey and Middlesex. It would be cheaper to reconstruct the works than to try and alter them. From an engineering point of view, the distributing plant could be divided, but only at great additional expense. The Company had already realized in their district the advantages that were enumerated by the Duke of Richmond's Commission as the desirability of transferring the water supply to a public authority. Though the Company had not control of the fittings, which the Richmond Commission thought necessary, the whole of their area within the county of London had been transferred to constant supply; but as a consequence of their not having control of the fittings, the supply per head was higher than it would have been. About 93 per cent. of the Company's district was on constant supply. The regulations as to fittings fell far short of those in use in the great towns of the North.

Major-General Scott: You have power to apply to the Local Government Board to amend the regulations?

Witness: Yes; and this has been a subject which the associated Chairmen have considered on more than one occasion. As a matter of fact, a Committee of the Engineers, of whom I was one, was appointed to draw up an amended series of regulations to submit to the Local Government

accordingly. Therefore the figure for comparison should include only the amount of economies effected in working at Widnes, which this year was 1·87d. per 1000 cubic feet over that of last year; making a total for this year's working of £1620. Their Engineer was a man who was always trying to go forward—a man of energy who desired to improve and take care of their interests; and the work he had done justified the arguments he (Alderman Timmis) had advanced in support of the Committee's recommendation. Mr. Davies seconded the motion, which, after some discussion, was carried by 14 votes to 9.

THE BRISTOL CORPORATION AND THE GAS COMPANY'S BILL

A Committee of the Bristol Corporation have presented a report on the Bill promoted by the Bristol Gas Company to obtain authority to erect works, to raise additional capital, and for other purposes (*ante*, p. 125). With regard to capital, the proposal is to increase the stock from £1,022,500 to £1,322,500, and the loans from £255,625 to £355,625. The Committee express the opinion that it is very questionable indeed whether so large an increase of the capital powers of the Company is necessary at the present time; and they consider that, in any case, no money to be obtained by borrowing should be raised by mortgage, but by the issue of debenture stock, subject to the auction clauses. The proposed powers to lay pipes and culverts in streets for the purpose of disposing of residuals, or for any purpose connected with the Company's undertaking, appear to the Committee to be most objectionable; but if granted they should in every case, it is urged, be subject to the consent of the Council, and to such limitations and conditions as they may impose. The clause empowering the Company to supply motors and dynamos should, in the opinion of the Committee, be strenuously resisted, as it would enable the Company, while preserving their own monopoly for the supply of gas, to compete with the Corporation in the supply of electricity; and not only so, but the proposal to repeal the provisions of the Act of 1853, requiring them to supply gas to the public lamps at a figure equal to the lowest price charged to a private consumer, would enable them to sell gas for the purpose of generating electricity at a low price, to the detriment of the consumers of gas for lighting purposes. The clauses as to notice to the Company by consumers quitting their premises, and for the alteration of pipes and fittings, should, in the opinion of the Committee, be amended so as to render a consumer only liable for the supply of gas before notice is given to the Company; and the alteration of any pipes and fittings constructed or fixed in accordance with the practice formerly adopted with the concurrence of the Company should be made at their expense. Further, the clause providing that when a meter is found to be erroneous the error is to be deemed to have arisen during the preceding quarter, should be amended by the substitution of the word "current" for "preceding." The Committee consider that the Bill should, in addition to other matters, provide that the obligation which the Company are under with reference to the area included in the city prior to its recent extensions should be extended to the whole of the existing city. They recommend that a petition should be presented against the Bill.

THE OPPOSITION TO THE YEADON AND GUISELEY GAS BILL.

A conference of representatives of the District Councils of Yeadon, Rawdon, and Guiseley and the Menston Parish Council was held last Monday week, for the purpose of considering a letter which had been received from Messrs. Watson, Son, and Smith, Solicitors to the Yeadon and Guiseley Gas Company, suggesting that an interview take place between them and the Clerks to the various Councils for the purpose of ascertaining what were the points in the Company's Bill objected to, and whether these could not be met in a manner satisfactory to both parties, without the expense of opposition. Mr. J. W. Pratt (Rawdon) proposed that opposition to the Bill be withdrawn, so far as regards the gas clauses, if the Company would substitute the net price of 2s. 8½d. per 1000 cubic feet now charged for the standard price of 3s. 6d.; such compromise to be subject to the approval of the ratepayers. The proposition was carried on the casting vote of the Chairman. It was further decided to ask the Company to withdraw the electric lighting clauses from their Bill. At a special meeting of the Yeadon Council on Wednesday, the Company's Solicitors' reply was read. They found it impossible to meet the consumers by fixing the standard price at lower than 3s. 6d., but thought the proper way was to provide that any benefits which might accrue to the Company under the Act should not be received by them if a higher net price than was agreed upon should be charged. A draft clause setting forth this proposal in legal phraseology was enclosed. The reply was considered by the Council to be unsatisfactory; but no decision was arrived at pending the ratepayers' meeting to be held in the evening. Subsequently a meeting of owners and ratepayers took place in the Town Hall—Mr. Thompson Marshall (the Chairman of the District Council) presiding. The Chairman explained that the Company declined to fix the standard price at 2s. 8½d. per 1000 cubic feet, or to withdraw from their Bill the electric lighting clauses. He proposed a resolution authorizing the Council to oppose the Bill, and to charge the cost on the district rates. Dr. Usher raised an objection to the wording of the statutory notice convening the meeting, contending that it was not in proper form. The Chairman ruled that the notice was in order, and said the Council would take the consequences. A lively discussion ensued; and eventually the resolution was carried with but one dissentient. Dr. Usher, amid great disorder, demanded a poll on the question. At meetings of ratepayers held in Rawdon and Guiseley, opposition to the Bill has been sanctioned.

Sales of Shares.—Last Thursday, Mr. S. Johnson sold £150 of consolidated "A" stock of the Elsecar, Wentworth, and Hoyland Gas Company for £260, £135 for £247, and £50 for £90. Some £10 shares (£9 paid) fetched from £16 to £16 8s. each. On Friday, Messrs. Darby and Co. disposed of five original £25 shares in the Chelmsford Gas Company at £49 each. Three £25 shares (additional capital), fully paid, in the same Company realized £35 10s. apiece.

ELECTRIC LIGHTING NOTES.

The Bury St. Edmunds Town Council have accepted tenders amounting to £15,250 for the construction of their electric lighting works.

The Electric Lighting Committee of the Hampstead Vestry report an increase of 41 per cent. in their consumers' accounts for the three months ending Dec. 31 last—£8312, as against £5892 for the corresponding quarter of 1897.

The Margam District Council resolved, at their meeting last week, to light part of the district with electricity at a cost of £6500. This will provide 1000 lamps; and it is anticipated that the capital will be repaid, with interest, in 25 years.

The Electric Lighting Committee of the Swansea Corporation yesterday week adopted a recommendation of a Sub-Committee that an amended application be made to the Local Government Board for sanction to raise a loan of £54,648 for electric lighting purposes.

The electric lighting undertaking at Walsall is not at present a financial success. The Electric Lighting Committee reported to the Town Council yesterday week that the loss on their operations last year amounted to £279 3s. 11d., and that the number of consumers now supplied is 139.

On Monday and Thursday last week, explosions occurred in an electric lighting culvert in Ann Street, Belfast, and violently dislodged the heavy flagstones of the pavement, and also the covers of the culvert boxes. The disturbance caused by the explosion on Thursday spread over the footpath for some 30 or 40 feet distance. It is supposed that escaping gas had found an entrance into the culvert.

A gradual progress continues to mark the business of the Newcastle Electric Lighting Company. The installations connected to the Company's system during the past year were equal to 3678 10-candle power lamps; bringing the total up to about 36,278 lamps. The electrical energy supplied amounted to 778,828 units, as against 642,969 units in 1897. An interim dividend of 3½ per cent. was paid; and a further 5 per cent. was declared at the meeting of the shareholders last Tuesday.

Once again the question of lighting St. Paul's Cathedral by electricity is being discussed; and it is announced that the Authorities have now obtained the money required for the installation—about £5000. It appears that there is a division of opinion as to the suitability of the building for electric light, and especially as to the disposal of the lights. The incandescent gas system has been on trial in the Cathedral, with very good effect; and one may ask: Why not continue and extend it?

Kingswood, near Bristol, is in the unfortunate position of being without any street lighting at night, in consequence of the electric light having been suddenly cut off. The explanation appears to be that the District Council agreed some time since to purchase the electric light works for £1250; and this they now refuse to do. As a result, the mortgagees of the Syndicate who have been running the installation have entered into possession of the property, and stopped the supply of current. A writ has also been issued against the Council for damages for breach of contract.

Mr. G. W. Willcocks held an inquiry last Wednesday at Wolverhampton, into an application by the Town Council to the Local Government Board for sanction to borrow £29,740 for the purposes of electric lighting. After explaining in detail the present system, the Town Clerk informed the Inspector that the maximum demand during the present winter was on Dec. 21, and amounted to 420 kilowatts, representing practically 90 per cent. of the total available capacity. The maximum demand for private lighting on the transformers was 300 kilowatts; representing about 95 per cent. of the total capacity. The number of consumers was 270; and the quantity of units supplied for the year ended March 31, 1898, was 291,233. If there was an increase in the same ratio in the ensuing year, the present plant would be entirely inadequate to meet the demand. It was further proposed to extend the supply, and to make improvements in the distribution system.

OPENING OF MESSRS. FLETCHER, RUSSELL, AND CO.'S NEW WORKS AT WARRINGTON.

Last Wednesday, Messrs. Fletcher, Russell, and Co., Limited, formally opened the new works they have erected at Warrington, which will not only largely increase their means of production, but will effect an important change in the general arrangement of their combined businesses of manufacturers of gas appliances and producers of various descriptions of ornamental castings. Hitherto the bulk of the castings for the gas stoves, cookers, &c., have been made at the Pendleton foundries. The entire manufacture of gas appliances will now be concentrated in the new Warrington works, and those at Pendleton will be devoted mainly to the manufacture of ranges, mantles, lavatories, and general light castings. The electro-plating, bronzing, and enamelling processes will also still be carried on at Pendleton, where, it may be mentioned the Company are now making a feature of a special enamel suitable for gas-stoves and other goods, which will stand the greatest possible heat without either cracking or discoloration.

The new works at Warrington, which have been laid out on the most modern lines, and, with the exception of the grinding-shop, are to be driven throughout by electric power (the same means being also adopted for lighting), are situated between the Wilderspool Causeway and the low-level siding of the London and North-Western Railway Company. They consist of a fine range of buildings covering something like five acres; an additional eight acres having been acquired which will be available for further extensions. The main entrance occupies the centre of a handsome building in brick and stone fronting to Wilderspool Road, and consisting, on the ground floor, of the time office, the inwards goods and stores departments, dining-rooms for the workmen, and temporary iron pattern stores. On the first floor are the offices and board-room, &c.; and on the second floor, large show-rooms. Entering the works, a large three-storey building, with spacious cellars and attic, is first approached. This contains the warehouse and despatch departments; and an electrically-driven hoist conveys the goods from floor to floor. Running alongside the southern part of the building is the loading-stage and shed, in direct connection with a double-line siding communicating with the London and North-Western Railway, where goods are placed upon the railway trucks ready for dispatch. On the south side of the warehouse department is the boiler-house, opposite which and immediately adjoining

the warehouse, are two one-storey buildings, consisting of the burner, gas-oven, and gas-fire testing departments; while under the same roof are the blacking-shop and store. Adjoining are the grinding and polishing departments. The engine-house contains a compound tandem engine indicating about 130-horse power; and from the main countershaft are driven two generating dynamos—one for distributing electric power to the various departments, and the other for the electric lighting of the works. On the left hand, or north side, is another block of buildings, two storeys in height, with commodious attics, containing, on the ground floor, the fitting-shop and the heavy machinery for stamping, drilling, &c.; and on the second floor the light drilling, fitting, and tinsmith's departments. All the machinery in these shops is worked by belt power from main shafts driven by electric motors; the same power driving the hoist for conveying goods from floor to floor. Near the western side of this block is the smithy and box-fitting department. Leaving the smithy, the stocktaker's department is entered. In a line, is the dressing department, where the castings are cleaned; while adjoining is the machine dressing department, provided with rumbling barrels and emery wheels, and a fan for extracting the dust from the various machines. Under the same roof, at one end, is the blower-room, containing the blower, driven by two electric motors, from which the air-blast is driven into two cupolas, each capable of melting 30 tons per day. Around the cupolas are erected the cupola stages and roofs, about 90 feet long, and 25 feet broad, provided with all the most modern appliances necessary for the production of light iron castings. The moulding-shops occupy the remaining portion of this building, and have an area of about 2400 square yards. These shops are well lighted from the roof, and also by electricity, with special arrangements for ventilation; and the entire floor is laid with brick and cement.

The general plan of the new works has been so carried out as to afford every facility for the economical and quick handling of the castings in the various departments, which are heated by steam, and, as already stated, electrically lighted throughout; while covered gangways connect the various buildings. Some portions of the works are not yet completed; but very shortly they will be in full operation, and will then be second to none of a similar kind in the United Kingdom. The Thynne Street establishment, it may be added, is being completely removed to the new works, where at present some 350 to 400 men are engaged; but this number will be increased to about 600 hands when the whole of the shops are fully running.

The formal opening of the works on Wednesday was made the occasion for providing an entertainment in the shape of light refreshments to Messrs. Fletcher, Russell, and Co.'s own staff of workmen and to the Contractors' employees; while there were also present a number of invited guests, for whom luncheon was served. The opening ceremony consisted in making the first castings from the furnaces. The blower was started by Mr. W. R. Neil at five minutes to two, the first iron coming down about 25 minutes later. The ceremony of tapping the first metal was also performed by him; and the first mould was filled with molten metal by Mr. A. White, the foreman moulder. Two very successful castings—one an ornamental teapot stand, and the other a gas-oven top—were produced; and the interesting ceremony having been photographed, the works were, amid loud cheers, declared to have commenced operations under most satisfactory auspices.

Reductions in Price.—As from the beginning of the year, the price of gas at Aldershot has been reduced to 2s. 6d. per 1000 cubic feet; and in Londonderry from 3s. 6d. to 3s. 3d. per 1000 cubic feet. The Directors of the Chelmsford Gas Company will reduce the price of gas as from June 30 next from 4s. to 3s. 9d. per 1000 cubic feet.

The Large Water Consumers of Stockton and Middlesbrough.—It was reported to the Stockton and Middlesbrough Water Board yesterday week that the large consumers have consented to accept the terms suggested at a meeting with various members of the Board, by which it was agreed that, if the Bill now in Parliament received Royal Assent, 3½d per 1000 gallons should be charged to consumers of not less than 5 million gallons per quarter, to be payable for twelve years, provided that on or before Aug. 13, 1900, contracts for the construction of the Grassholme reservoir and the Longnewton service reservoir had been sealed by the Board, failing which the charge was to revert to 3d. per 1000 gallons.

The Smethwick Gas Undertaking.—At the monthly meeting of the Smethwick District Council last Tuesday, the Gas Committee reported, with reference to the petition of the gas workmen for a re-arrangement of their work and wages, that the Sub-Committee, having discussed the matter with the men, recommended certain alterations which met with the approval of the men; and the Committee had adopted the recommendation. The increase in the wages account caused thereby would be about £333 per annum. The Chairman of the Committee (Mr. J. Stones) remarked that, though there had not been any foggy weather, and the demand for gas was not so great last year as before, they made a profit of £3979; being an increase of £941 as compared with 1897. The sales of gas had also gone up by about 7 per cent. It was proposed to again contribute £2000 out of the profits for the relief of the district rates. The report, which was considered very satisfactory, was adopted.

The Hastings Gas Company's Bill.—A special meeting of the Hastings and St. Leonards Gas Company was held on the 9th inst.—Dr. Gray presiding—to consider the Company's proposed application to Parliament for further powers. The Chairman moved a resolution formally assenting to the Bill. In so doing, he said the Bill consisted of a preamble, 55 clauses, and two schedules. The preamble gave the history of the Company, and a summary of the provisions for which they were applying. It also contained a clause enabling them to complete the provisional agreement for the purchase of about 14 acres of land at Glynde Gap, and also not more than 9 acres for the general purposes of the Company should it become necessary. Exception had been taken to this matter on the ground that the Corporation were going to suffer, because if the works were removed coal dues would not have to be paid. He did not think there was much in this objection to gain favour in Parliament. It would be impossible, he pointed out, to move the works in a day. Such a change must be a gradual process. Moreover, if the works were removed, the present site would be available for building purposes, and thus create additional rateable value. The motion was carried.

METROPOLITAN WATER SUPPLY COMMISSION.

Fifty-First Day—Monday, Feb. 13.

(*Viscount* Llandaff, *Chairman*, *Sir* John E. Dorington, Bart., M.P., *Sir* G. B. Bruce, M.Inst.C.E., *Major-General* A. de Courcy Scott, R.E., *Mr.* A. de Bock Porter, C.B., *Mr.* H. W. Cripps, Q.C., and *Mr.* R. Lewis.)

The Commission sat at the Guildhall, Westminster.

The following are the Counsel engaged: Mr. Pope, Q.C., and Mr. Claude Baggallay, Q.C., for the New River and the Southwark and Vauxhall Water Companies; Mr. Littler, Q.C., and Mr. Lewis Coward for the Kent Water Company; Mr. Pember, Q.C., for the Lambeth, East London, Grand Junction, and West Middlesex Water Companies; Mr. Rickards for the Chelsea Water Company; Lord R. Cecil for the Hertfordshire County Council; Sir Joseph Leese, Q.C., M.P., for the Kent County Council and Kent Local Authorities; Mr. Balfour Browne, Q.C., and Mr. Freeman, Q.C., for the London County Council; Sir R. Nicholson for the Middlesex County Council; and Mr. Gabriel P. Goldney (Remembrancer) for the Corporation of the City of London.

Mr. *J. W. Restler*, Engineer to the Southwark and Vauxhall Water Company, said the area of the Company's district was 50½ square miles, with an estimated population supplied in 1898 of 819,901. The West Middlesex, Lambeth, and Kent Companies had power to supply in the Southwark and Vauxhall Company's district; and four-fifths of the Company's area was within the Lambeth Company's district. He knew of no instance since 1852 in which pipes of two Companies had been laid side by side in the same street. There had been no competition between the Southwark and Vauxhall Company and any other Company since that date, though in some cases the two Companies were supplying adjoining houses in the same streets.

The Chairman: You do not know whether the Lambeth Company make any difference in their charges in those streets in which they are supplying alongside you?

Witness: Yes. I think the Lambeth rates and ours are the same in the joint districts.

They have been reduced to your level?—Yes.

Then competition has reduced their charges where they have come in contact with you?—Yes. By joint district I mean the streets in which the pipes of both Companies are actually laid. Section 23 of the Southwark and Vauxhall Act of 1884 authorized the Company to enter into agreements against competition with other Companies. At the present moment the parish of Battersea is divided between the Southwark and Vauxhall and the Lambeth Companies. The complaints in the district are very few; the average last year being 1·71 per day over the entire district. There was only one complaint during the whole year as to quality. They were practically all of short supply. The Company's supply, as a fact, was not short; the vast majority of the complaints being due to defective fittings.

I think it was in your system that the instance was given us of 16,000 bacteria being found in a cubic centimetre?—Yes. It occurred on Dec. 8, 1896. Directly it was discovered Dr. Frankland wrote, and a filter which had just been put to work was stopped. The sand was opened up, and a careful examination made; but nothing was discovered to explain it. The filter was started again, and has worked satisfactorily since.

It is a little alarming to hear of 16,000 bacteria in a cubic centimetre, and no explanation?—Yes. We made every effort to trace it. The only question that was raised was whether the assistant, in taking the samples, might not have confused them.

Major-General Scott: Do you consider it would be a good addition to your filters to have a means of gauging the velocity of filtration—ascertaining it by means of an indicator?

Witness: I do think so. I think it most desirable; and to show how sincere I am in the belief, I have already an apparatus suspended to our No. 2 filter at Hampton. It is being tried now with a view to being applied to every filter we have. In addition to the person in charge being able to see the rate, I think it should be recorded on a diagram. The apparatus will be working in a very few days. If the results are what I hope, it should be compulsory on all the Companies to use the apparatus.

Further examined by the Chairman: The proposal to divide the works of the Southwark and Vauxhall Company between London and Surrey was based on a 12-inch main between Hampton and Richmond, which, as a fact, did not exist. Of the two mains of the Company, neither could be employed for the separate use of Surrey without considerable loss. The requirement of Surrey was only 2 million gallons a day, and the carrying capacity of the smaller of the two mains was 8 million gallons daily; so that 6 million gallons capacity would be wasted. He did not think it would be possible to separate the inlet works between Surrey and Middlesex. It would be cheaper to reconstruct the works than to try and alter them. From an engineering point of view, the distributing plant could be divided, but only at great additional expense. The Company had already realized in their district the advantages that were enumerated by the Duke of Richmond's Commission as the desirability of transferring the water supply to a public authority. Though the Company had not control of the fittings, which the Richmond Commission thought necessary, the whole of their area within the county of London had been transferred to constant supply; but as a consequence of their not having control of the fittings, the supply per head was higher than it would have been. About 93 per cent. of the Company's district was on constant supply. The regulations as to fittings fell far short of those in use in the great towns of the North.

Major-General Scott: You have power to apply to the Local Government Board to amend the regulations?

Witness: Yes; and this has been a subject which the associated Chairmen have considered on more than one occasion. As a matter of fact, a Committee of the Engineers, of whom I was one, was appointed to draw up an amended series of regulations to submit to the Local Government

Board. This had been done; but owing to the pressure of this Commission and other matters, the draft regulations have not yet been presented. The improvement in quality recommended by the Richmond Commission had been effected, as was shown by the Balfour Commission report.

The CHAIRMAN: Do you defend the exemption of the Companies from failure of supply on account of frost or drought, or other unavoidable cause or accident?

Witness: Yes. My experience is that the same causes bring about the same results, whether the supply is in the hands of the Municipalities or of the Companies.

It does seem to require a little justification that the Companies should go on collecting their charges although they give no water?—It is hardly correct to say they give no water, because in times of frost the quantity supplied exceeds that given even in times of drought. It is not as if the Companies saved anything in consequence of the frost; the contrary is the fact. The cost of a frost to the Companies is enormous.

The CHAIRMAN remarked that it seemed very hard that during last year's drought services should have been entirely cut off in East London, while the consumers had no remission of charge.

Mr. PEMBER pointed out that the consumers paid for the supply generally with that particular condition attached as a liability.

The CHAIRMAN said he had received a number of letters from gentlemen in which they said they wished for relief from payment of the high-service charge, but were refused.

In further examination, witness said, with reference to Sir A. Binnie's evidence in disparagement of the Company's supply from wells, that these wells were yielding 2½ million gallons daily; and the Company were sinking two other wells. The supply in the district was calculated by taking the population according to the census of 1891, and multiplying by the inhabitants per house (6·71). The Balfour Commission took the average decennial increase in Greater London at 18·2 per cent., the Southwark and Vauxhall proportion of which would be 13·51 per cent. Assuming the increase in the district was at this rate of 13·51 per cent., the population in 1898 would have been 831,754, which, at 35 gallons per head, would require a daily supply of 29,111,390 gallons, whereas the actual supply was 32,748,058 gallons. This was because the consumption was more than 35 gallons per head. He hoped, however, the supply would be reduced to 35 gallons per head. The actual rate of increase in the Company's district since the Balfour Commission was equivalent to a decennial rate of 10·79 per cent. The quantity of water the Company would require in 1941 would be between 44 and 61 million gallons daily, according to the basis of calculation taken. The Company's average daily supply in the last twelve months was 32,742,000 gallons. On the basis of 13·51 per cent. increase, the Company would have to supply, in 1941, 50,150,870 gallons daily; the estimated cost of doing which was £2,000,000. This assumed the possibility of the recurrence of a year like 1898. He assumed the Company would ultimately obtain 10 million gallons a day from wells.

By Major-General SCOTT: Sir A. Binnie's figure of £483 per million gallons as the cost of the authorized reservoir of the Southwark and Vauxhall Company, of 1076 million gallons capacity, was not correct, as it included culverts, the river intakes, and all incidental work.

Sir G. BRUCE: Do you think it would be wise to go to the expense of millions to provide for the contingency of a year like 1898, which seems to occur only once in a century?

Witness: No; it seems to me a most improvident suggestion.

Would you rather suggest that the businesslike way would be to look at it as other places do—to let London be content with a smaller supply, rather than go to the expense of millions, where the machinery would stand idle for fifty years perhaps?—I do not think London need go short. It can have all it requires; and the Companies can, at a very moderate cost, put up the necessary machinery to do it, if their hands are not tied to the guaranteed minimum flow over Teddington Weir.

Cross-examined by Mr. BALFOUR BROWNE: There was nothing on the minutes of the Company pledging them not to compete in other districts. In the areas of the Lambeth and Southwark and Vauxhall Companies there was a considerable amount of building to develop estates going on; and the builder could lay the supply of water on from either Company, as he liked. In that case, the supply would be at the Southwark and Vauxhall Company's rates. With regard to the finding of 16,000 bacteria in a cubic centimetre of water, samples of water were taken daily, and (he presumed) analyzed daily for bacteria. He did not know that on occasions in 1896 and 1897 the bacteria numbered 1396, 728, 764, and so on, per cubic centimetre. Concerning the gauging of the rate of filtration, he agreed that apparatus for the purpose had been used for years in other large water-works in the country. The large main of the Company from Hampton to London was designed and laid by witness, at a cost of £160,000, between 1887 and 1891. Owing to the yielding nature of the soil when wet, repairs totalling £35,000 were executed on it; but only the cost of the main was charged to capital—not, for instance, the cost of the second opening of the road.

By Mr. BAGGALLAY: If there were competition in the same streets between the Companies, there would be a great increase of inconvenience to the public in case of a leak, owing to the difficulty of locating it. The water used at fires was not material; the loss occurred through water escaping at defective fittings, consequent on the extra pressure then put on the mains. The Southwark and Vauxhall Company had statutory power to sink wells on all their land.

Mr. *Edmund Boulnois*, M.P., Chairman of the West Middlesex Water Company, and Chairman of the Staines Reservoirs Joint Committee, examined by the CHAIRMAN, said that, owing to careful management, the Company had reached the fortunate position of paying their maximum dividends in 1879, and they completed the payment of back-dividends in 1887. There could be no advantage to the consumer in purchasing the West Middlesex Company, because they had reached the payment of their maximum dividend, and would continue to earn it, so that the surplus (which at present was about £20,000 a year) must go to the consumer. It could not be alleged against the Company that they had no interest in looking after the consumers, because in the past they had increased the rebate from 5 to 10 per cent. by careful management. He very much doubted if, supposing the management had been in the hands of representatives of the consumers, the rebate would have been greater. If the Company had been let alone, and had not been made to spend enormous amounts in defending themselves during the last few years, they could have largely increased the rebate.

The CHAIRMAN: Do you think that the management by representatives of ratepayers and of the consumers would effect more economies, and do better for the consumer, than the management of the West Middlesex have done?

Witness: Personally I do not think that would be the case, because the expenses of management have not increased disproportionately since the maximum dividend was paid to our shareholders. If there were any inclination on the part of the Directors to lavish expenditure, it would have become apparent by this time. The Company are not in a position of having no pecuniary interest, because their payments to the sinking fund might ultimately trench upon the 10 per cent. dividend, after absorbing the rebates made to the consumers. There would be no appreciable saving in management resulting from a purchase of the undertakings. Without Directors, they must have a highly trained staff of officials. The County Council were a shifting body; and the Committee managing the concerns would be of a similar character.

Any Company who had reached their maximum, must be bought at a disadvantage by any public authority?—Yes.

And the nearer they had got to their maximum, the greater the disadvantage?—Yes.

By Mr. DE BOCK PORTER: As the Southwark and Vauxhall Company had paid all their back-dividends, and were now paying their maximum statutory dividend, if the stockholders, in case of purchase, received their present income, amply secured, they could raise no objection. Still he thought they should go to arbitration, because no arbitrator, in the case of the West Middlesex Company, could give less than that income. He did not see why the Metropolitan Water Companies should be treated in a different way from others who have been acquired by a municipality. He believed he was right in saying there was no instance in which a water company had been taken over by a municipality except under the Lands Clauses Act, unless by their consent.

The CHAIRMAN: What more do you think you would get by arbitration than your present income secured? What more do you think you ought to get?

Witness: I think I ought to get something for compulsory expropriation. I am quite satisfied to remain as I am; and if I am taken over I ought to have some solatium.

You regard West Middlesex shares as next door to Consols?—Equal to Consols.

Do you think the sinking fund clauses will end by diminishing or doing away with the rebate you have been able to make to the consumers?—I think it must eventually turn out so. We shall have to pay something like £20,000 a year to the Chamberlain, and that is a little short of the amount we give the consumers now. Quite possibly the sinking fund may also interfere with the dividend. Even having regard to this, I prefer going to arbitration to accepting annuities. Parliament may treat the Companies a little more fairly in the future than in the past.

Mr. PEMBER: I suppose your evidence is given on the assumption that the sinking funds will be abolished if purchase does not take place?

Witness: Certainly.

Further examined: If the County Council were the purchaser, and they went to Wales, the necessity for so doing would be largely to meet the needs of outside districts, while the expense would fall as much on the London ratepayer as on the outside ratepayer. This would be making the London ratepayers pay for what were not London needs. He could suggest no scheme of amalgamation or purchase by which this injustice could be avoided, except that the Companies should remain *in statu quo*. If necessary, the Companies were quite capable of combining in order to go to Wales.

The CHAIRMAN: But you see they shirked even the comparatively trivial expenditure of the Staines reservoirs scheme—only three of them had the courage to join it.

Witness replied that they must proceed by degrees in this matter. The Staines reservoirs scheme was a new departure, and Water Companies were like other bodies—they did not move so rapidly perhaps as individuals. But he looked forward to the time when the whole of the Companies would come into one scheme of either amalgamation or federation. There were difficulties in the way of amalgamation, but they were not insurmountable. The Gas Companies had amalgamated; and he saw no reason why the Water Companies should not. Equalization of rates was practicable, but would raise a great outcry. He saw no necessity for further control—the Companies being already controlled in a manner peculiar to London, by the Water Examiner, the Analyst, the Government Auditor, and the Railway Commission.

Cross-examined by Mr. BALFOUR BROWNE: He thought there would be no advantage or disadvantage in amalgamating the Companies. Amalgamation would involve equalization of rates. He was not sure that if the Southwark and Vauxhall Company had had to supply in districts common to them and (say) the Lambeth Company they would have been able to supply at the present low rates. The cost of doing so might have been greater than in the present district of supply.

The CHAIRMAN: The inference I draw is that their rates would not pay them to go to Lambeth, and that is the reason why they did not go.

In further cross-examination, a considerable number of questions were put to witness with a view to showing that the expenses of maintenance and management were considerably higher, after the period when maximum dividends were paid and arrears caught up, than they were before. Witness, however, said he was not cognizant of the facts, but believed there was a complete answer to the suggestions, which would be given if the question were put to the Secretary.

Witness, as he was about to leave the box, expressed, as Chairman of the Staines Reservoirs Committee, the gratification he should feel if he could induce the Commission to pay a visit to the works, which were now so far advanced that they would give a very good idea of how they would eventually appear.

The CHAIRMAN thanked witness for the invitation, which personally he should be very pleased to accept, though he could not pledge the Commission on the point.

Fifty-Second Day—Tuesday, Feb. 14.

All the Commissioners were present to-day.

Mr. *F. H. Wybroo*, Secretary of the West Middlesex Water Company, stated that since Midsummer, 1894, the rates paid by the consumers had

been 10 per cent. less than the maximum which the Company were permitted by law to charge; and the total amount of rebate so allowed amounted in all to £201,787. The Company still had the power of charging the full rates given them by their Special Act of 1852, if it should be necessary to do so for the purpose of maintaining their 10 per cent. dividend. For instance, in 1895, in consequence of the expenditure caused by the great frost, the Company's income was insufficient without reducing the rebate to pay the 10 per cent. dividend; and rather than so interfere with the rebate to the consumers, the Directors took £20,000 from the reserve fund. But there was no obligation on the Company to do this; and they might have reduced the rebate and increased the charge to the consumers, and thus raised the £20,000 instead of taking it from the reserve fund. The Company claimed still the right of increasing the charges in order to replace the amount taken from reserve. As regarded the incidence of charges, it was not correct to state that the poorer class paid more than the rich for water. On the contrary, they paid less. The tenant of a house of the annual value of £30 used nearly as much water as the tenant of one of £50; and the same comparison would hold good between houses (say) of higher value. But the water-rates paid were much lower, more especially in the case of all houses rated at £30 and under; no extras being charged on these. Referring to the evidence of Mr. Haward, the Comptroller of the London County Council, witness disputed the accuracy of his inference that the cost of management of the Company had been unduly increased in consequence of its prosperity. Witness had worked out tables for the last 25 years, showing that the relative expenditure of the Company was no higher, and that in fact it was lower than when the Company were not paying their full dividend; whereas now they were paying 10 per cent., and making a rebate to consumers which was equivalent to earning a further 2¼ per cent. dividend. A reference was also made by Mr. Haward to the issue of £200,000 debenture stock sanctioned under the West Middlesex Water-Works Act, 1869 at par, when it might have been issued at a premium. This was strictly in accordance with the Company's rights; but it might also be pointed out that the Company could have issued the debenture stock at such a rate of interest as they thought fit, and have put a much higher rate than 4½ per cent. on the stock. Further, it was thought that under the provisions of the Companies Clauses Act the Company could, if they had pleased, have issued the £200,000 debenture stock as ordinary stock of the Company, which was then bearing 10 per cent. dividend, and consequently would have commanded a very much higher premium than the debenture stock actually issued. The Directors did not adopt this course, which would have involved an increased payment to the stockholders of £11,000 per annum. With regard to the question of expenditure of income by the Company on capital works, they always considered that they had no power to do this; and until the West Middlesex Company's Act of 1894, they were not given any express power to do so. By this Act, the Company were empowered and directed to spend for capital works £60,000 of accumulations of income. These accumulations had grown up little by little, as the result of the annual surplus extending over very many years, which had been collected as revenue over and above the actual requirements of the Company. It was true that as regards the expenditure of income by the New River Company on capital works, to which Mr. Stoneham referred in the Local Government Board report, the Auditor there took an opposite view to that held by the West Middlesex Company; but he there complained that the New River Company should thus spend income.

The Chairman: I see by your tables that in 1887 you spent £13,781 on filtration and in 1888 £11,331, while in the next year it dropped to £5031. It is an odd coincidence that these large amounts should have been spent just at the time when there was nothing to divide.

Mr. Pember: I think it is merely a coincidence.

Witness: I cannot say anything more than that it was a coincidence. The work was not done before it was required.

Examination continued: As regarded the so-called revision of the capital of the Company, it was true that in 1852 Parliament reduced the nominal capital from £830,000 to £506,300, and made a similar proportionate reduction in the amount of the shares from £100 to £61; but this was not done for the reason stated by Mr. Gomme. The exact amount paid up by shareholders in respect of the nominal capital was only £395,450. But it was proved that the Company had expended out of income in respect of capital outlay £111,247.

The Chairman: At that time you had power to spend your income in capital outlay?

Witness: Yes, Parliament sanctioned it being done.

The Chairman: Why did they lop off the difference between £830,000 and £506,300?—It was proved that, though some of the capital was raised at par and the shares were fully paid up, other capital issued at the beginning of the century, when public credit was very low, had been raised at no less than 70 per cent. discount.

The Chairman: My question was why did not Parliament allow the full £830,000?—The authorized capital of the Company in 1852 was only £400,000. In order to get this, they issued 8300 shares of the nominal value of £100 each, for which the Company only received £395,450; and Parliament allowed what we actually received.

Examination resumed: The capital of the Company, therefore, was fixed by Parliament at an amount actually in excess of what had been paid up on the shares; and the Company were allowed to take into account as part of the paid-up capital the sum of £111,247, or thereabouts, and were given the statutory power of charging rates on the scale fixed by the Act of 1852, for the purpose of paying a maximum dividend of 10 per cent. on this capital. Prior to 1852, the Company had no power to charge any sum for the supply of water except by agreement. By this Act they were also relieved from compulsory competition with other Companies; and they were empowered to move their intake from the tideway at Hammersmith, where they had been previously drawing water, to the Thames at Hampton. Therefore, when this capital was fixed, Parliament must have had fully in mind that the intake was going to be moved; and an increase of capital for this and other purposes was sanctioned by the Act. There was no foundation for the criticisms as to writing off for depreciation. Regarding the suggestion that the Local Authorities were very much in the hands of the Companies as to the charge made for water for street watering and flushing sewers, in 1888 the Paddington Vestry applied to the Magistrate at Marylebone Police Court to settle the rate to be charged by the West Middlesex Company; and the rate was fixed by the Magistrate at 8½d. per 1000 gallons. In reference to the alleged increase of certain maintenance charges, witness pointed out that Mr. Gomme had omitted the items over which the Company had no control—rents, payments to the Thames Conservancy, and rates and taxes—which showed a greater increase than the others. The Directors watched carefully every item of expenditure, and permitted nothing beyond what was necessary for the proper working of the Company. The Company's powers of supply, storage reservoirs (independently of those now being made at Staines), filters, engines, and other works, were quite sufficient for their present requirement, and if it were not for the demand for supplies to new houses, which would bring increased revenue, there would be no necessity for further expenditure for fresh works. The Company, though entitled to do so, did not increase the rates charged on any house in 1852, unless there was a change of tenancy or alteration in the supplies or premises, until the decision in the Dobbs case in 1884 rendered necessary a revision of the rates, which resulted in an increase of revenue. But even then the rates were not charged on the full "rateable value," as the effect of the second revision which had to be made in consequence of Torrens' Act in 1885 was a further increase. The net income being more than sufficient to pay the statutory dividend, a rebate of 5 per cent. was allowed from Midsummer, 1887, from all rates, whether charged on rateable value or under agreement, and from all meter supplies. This rebate was increased to 7½ per cent. from Christmas, 1890; and from Midsummer, 1894, to 10 per cent. As regarded the consumers within the Company's district, it was quite impossible that they would be benefited by any purchase. Having stated his objections to supply by meter for domestic purposes, witness remarked that considerable stress had been laid upon the benefits alleged to be derived by the Companies from quinquennial revisions due to the general increase of assessments without any alteration of the premises; but it would be noted that the amount from which the Company would benefit, after deducting the amount of the assessments which were lowered, was £12,354, which, at 4 per cent., would represent an increased income of £494. The assessments in these parishes were increased at the last revision by £12,826, on which rates had to be paid of more than £3000 per annum. The assessments were increased in 8944 cases, and reduced in 14,271.

Mr. *M. W. Hervey*, Engineer to the West Middlesex Water-Works Company, having described the whole of the Company's works as being in a thoroughly efficient condition, and with the addition of works in progress and in contemplation capable of meeting all the requirements of the district in the immediate future, went on to say that the area of supply in the Company's district was 27 square miles, of which 9½ square miles were in the county of London, and 17½ square miles outside. The number of supplies in these respective areas on December 31 last was: Inside the county of London, 62,262; outside, 21,128. The rate of increase of supplies was about five outside to one inside. At the present time, the Company were empowered to take 24,500,000 gallons per day from the River Thames; and when the works now being constructed under the Staines Reservoirs Act of 1896 were completed, the Company would get an additional 11,670,000 gallons per day, or, in case of emergency, 15,000,000 gallons per day; thus giving an authorized take of 36,170,000 gallons, or, in case of emergency, 39,500,000 gallons daily from the Thames and the Staines reservoirs. Assuming the population to increase at the rate of 22·63 per cent. every ten years, it would amount in 1922 to 1,041,731. To supply this population with 35 gallons per head per day, would require 36,461,585 gallons; so that the Company's present authorized take of water would suffice till the year 1922. On the basis of the same decennial increase, the population in 1937 would be 1,411,967, and would require, at 35 gallons per head, 49,418,845 gallons, or (say) 10,000,000 gallons, per day beyond the present authorized draught of the Company, and the maximum supply from the Staines reservoirs now constructing. Witness estimated the capital expenditure necessary to provide for this increase at £1,250,000, was made up as follows: Additions to Staines reservoirs, £300,000; enlargement of reservoirs at Barn Elms, so as to add 25 per cent. to storage capacity, £50,000; covered reservoir, £50,000; filter beds, £150,000; mains, including 42-inch main from Hampton to Barnes, contemplated by the Company's Bill of this session, £300,000; engines, boilers, and buildings, £200,000; and ordinary expenditure on services, £200,000. Since the severe frost of 1895, the Company had lowered all small mains and services known to be shallow to a depth of 3 feet below the surface of the ground—in all about 40 miles in length—at a cost, including other frost expenses, of about £33,000. Very few customers had made any alteration in their communication-pipes, either by laying them deeper or protecting them from frost; so that in the event of a similar frost to that experienced in 1895 the condition of things would be little improved as far as the actual supply into the houses was concerned. Severance between the county of London and the county of Middlesex would, as far as his Company were concerned, lead to many difficulties and complications, which would be almost insuperable. Having refreshed his recollection of the exact particulars of cleaning a reservoir of the West Middlesex Company, which had been referred to, witness was able to state that the water area of this reservoir was 6 acres, the depth 16 feet, and it had not been cleaned out for thirty years, when it was cleaned in 1897 under his personal supervision. After all the water had been run off and the mud cast up in heaps to drain it as much as possible, it was found there was an average deposit of 8·42 inches of mud, in which there was at least 50 per cent. of water. The total solid matter would, therefore, represent less than half this thickness of liquid mud. The average thickness of the deposit was derived by dividing the area of the bottom of the reservoir into the actual measurement of the total mud in the reservoir which was ascertained as the mud was removed in barges.

Mr. *F. Tendron*, Chairman of the Grand Junction Water-Works Company, stated that they were prepared to carry out all the works necessary for the supply of water to their district, either by themselves or in confederation with the other Companies. Witness expressed the opinion that purchase would be no advantage to the consumers, because he believed that if the undertaking were left in the hands of the Company they would attain their 10 per cent. maximum dividend, and possibly pay off their back dividends, so as to enable them to give a rebate as soon as, if not sooner than, any public purchasing authority would be able to arrive at a similar financial result. He considered the present market price of £112 to £115 per £50 share of his Company really did not represent

anything like the full value; and inasmuch as for the last two years the Company had been earning 9 per cent.—though they only paid 7½ per cent.—he contended that if purchase should be decided upon, the undertaking should, in fairness to the shareholders, be bought, not upon present market value, but upon present and prospective income.

The Commission then adjourned.

The fifty-third sitting of the Commission was held yesterday at the Guildhall, Westminster—Lord Llandaff presiding. Mr. Tendron, Chairman of the Grand Junction Water Company, was recalled. In the course of further examination by the Chairman, he handed in statements giving a description of the works of the Company, a table showing the average daily supply of water, a return as to the pumping and other mains, and a description of the engines and various other works; also financial returns as to distribution of capital, the ordinary and debenture stock, and the officers. He proceeded to put in elaborate estimates of the cost of the future needs of the district, calculated on varying bases of minimum flows at Teddington, of increase of population, consumption, &c.

THE CORPORATION OF LONDON AND THE WATER QUESTION.

Last Tuesday, a Grand Committee, consisting of the whole of the Court of Common Council of the City of London, sat at the Guildhall, to consider what action the Corporation should take with respect to the future supply of water to the Metropolis. The proceedings were private; but we learn from the "City Press" that the following questions were submitted to the Committee:—

Is the Commit ee of opinion that the eight Water Companies should be purchased on behalf of the public?

Is the Committee of opinion that such purchase should be effected by the London County Council alone, or by a Joint Committee constituted by statute in accordance with the previous agreements providing for a seven-eighth representation in respect to the London County Council and a one-eighth in respect to the Corporation?

Does the Committee approve of the functions and duties delegated to the Water Companies as provided by the County Council Bill?

Does the Committee consider that any alteration should be made in the existing method of charge for water, and, if so, that such alterations should form part of the Bill?

According to the above-named authority, a private circular had been issued to members, in which it was stated that the Stock Exchange valuation of the Companies' undertakings on Dec. 31, 1896, was 39 millions; but that the actual share and loan capital (at par value) was 16 millions, and that the average return to the investor was 3 per cent. Four Water Bills, the Committee were reminded, were being promoted by the London County Council this session; one dealing with the purchase of the Companies' undertakings, the second and third giving effect to a scheme for bringing water from Wales, and the fourth providing for the financial arrangements involved in the three preceding Bills. Another circular, signed by Mr. Henry Clarke, was placed before the members. It opened with the following statement: "Of the various methods of dealing with the Companies—viz., compulsory purchase as proposed by the London County Council, control without purchase, and negotiation with the view to friendly purchase—the last is the one which forms the basis of the scheme here submitted. The first has been tried, the second is considered impracticable, and the question is ripe for negotiation." The memorandum concluded with the subjoined remark: "As to the Companies' view of the transfer, it is notorious that they are weary of the continual menace of compulsory purchase; and they are conscious that it is alleged that their dividends have been increased by illegal charges, and that they have no monopoly. Neither can they forget that when in 1880 it was proposed to pay them 32 millions, the Metropolitan Board, the City Corporation, and the Vestries asserted that this was 9 millions too much, and offered fierce opposition, which proved disastrous to the Government. No doubt, therefore, they would welcome negotiations on reasonable terms, particularly as they have to face an expenditure variously estimated at from 10 to 20 millions for storage reservoirs, or even more for a supplemental supply."

The meeting lasted just two hours; but no definite result was arrived at. Mr. W. H. Pannell, in the absence through illness of Mr. Clarke, moved the following resolution: "That a Water Authority of a representative character should be constituted, and that on such a body should devolve the responsibility of determining questions affecting the source, the nature, and the price of the water supply of the Metropolis." To this the following amendment was proposed: "That the most effective means for conducting satisfactorily the water supply of the Metropolis will be the formation of a body composed by an amalgamation of the existing Companies, their united directorates forming a Statutory Water Council, after adjustment of their various financial interests; thus leaving the whole control in the hands of men of mature experience, and practically acquainted with the work." A subsequent amendment was moved by Mr. Ashby, to the effect that, "Inasmuch as the whole question is now under the consideration of a Royal Commission, no action shall be taken by the Corporation until after that Commission reports." The motion of Mr. Pannell was negatived by a large majority; and the amendment of Mr. Ashby was carried.

THE PROPOSED WELSH WATER SCHEME FOR LONDON.

As briefly noticed in the article on "Water and Sanitary Affairs" last week, a discussion on the above subject took place at a meeting of the Sanitary Institute at the Parkes Museum, Margaret Street, W., on the 8th inst. It was evoked by a paper on "The Supply of Water to London by the Welsh Scheme," prepared by Mr. R. E. Middleton, and read in his absence by Mr. Walter Hunter, co-Engineer with Mr. Middleton to the Staines Reservoirs Joint Committee. Sir Douglas Galton, Vice-President and Chairman of the Council of the Institute, presided.

Mr. Hunter prefaced the paper by remarking that, while concurring generally in Mr. Middleton's several conclusions, he did not hold himself responsible for his details, though he had no doubt, from the author's point of view, they were accurate. Mr. Middleton referred to the finding of Lord Balfour of Burleigh's Commission in 1892, that the present sources of water supply for London were of unexceptional quality and ample in quantity, and said that notwithstanding this decision by a Commission appointed at the request of the London County Council, notwithstanding the fact that in 1896 Parliament granted to the Staines Reservoirs Joint Committee power to deliver an additional quantity of 35 million gallons of water daily, and in 1898 gave to the Southwark and Vauxhall Company power to take 20½ million gallons a day in excess of their authorized draft from the Thames, and notwithstanding that their witnesses had declared their intention of maintaining a supply of 185½ million gallons a day from the river, the County Council had deposited Bills for the construction of reservoirs in Wales, and aqueducts to bring water therefrom to Elstree, and thence to the London consumer, utterly regardless of the finding of Lord Balfour's Commission, of cost, and of the consumers' and ratepayers' interests. Having sketched the scheme of the Council, the author proceeded to state that neither the Yrfon nor the Wye would yield anything like the quantity of water required from them day by day without storage; but the Thames would yield a far larger daily supply without storage than the Wye and the Yrfon, and equally would it yield a far larger supply with storage than would those rivers. If so large a supply was available near home, it might well be asked why they should go to Wales, especially as, on the showing of the County Council, the cost of bringing the water would be greatly in excess of the cost of drawing a similar quantity from the Thames, storing so much of it as was required for use in the summer, when the flow of the river was comparatively small, and pumping the whole quantity for the supply of the several districts. If decided upon, the Welsh scheme would by 1948 have cost £61,500,000, as compared with £18,250,000 if the Thames were drawn upon. If London were in the position of Manchester, Liverpool, or Birmingham, with supplies exhausted, and without the possibility of augmenting them, except by going to some distant watershed, people in London could but make up their minds to go to Wales or elsewhere to obtain a further supply; but when it was shown that the magnificent river flowing through the Metropolis could afford a more than sufficient supply of water of the best quality, and at far less expense, the reason for going to Wales disappeared. Should the ratepayers of London persist in the introduction of a supply from Wales, they would regret it once only, and that once would last as long as they lived.

Major Flower, Sanitary Engineer of the Lea Conservancy, speaking mainly for the Lea district, said he had had the honour of being a witness before Lord Balfour's Commission, and the conclusion come to was not to go to a foreign source for the supply of London, but to take care of the resources already possessed. The Staines reservoirs scheme was being completed; and he did not think when it was finished there would be any reason to complain of the want of water from the Thames and the other home sources. It might be very nice to go to Wales for water; but how did we know that we should get it pure? How would London people like peaty water? It was objected that the London water was very hard; but it was very healthy, and London stood a long way above any other town in the country in regard to health. It was necessary to consider what was the decomposing effect of soft water on lead pipes. If we were going to build a new London, we might think of getting a supply of water from another quarter; but his contention was that so long as we had got such sources of supply as we already possessed, the proper thing to do was to take care of these, be content, and be thankful with the Thames, the Lea, and the very large subterranean sources of supply in the watersheds of these rivers.

Dr. Childs thought Mr. Middleton had made out a very good case for the existing supply, and against going to Wales. If his figures were correct, he clearly established the fact that fifty years hence there would be a sufficient supply from the watershed areas of the Thames and the Lea without going farther afield. As to the quality of the London water, chemical and bacteriological analyses showed that it was reasonably pure, and that the quantity of foreign matter was infinitesimal; while the mortality reports did not show any excess of diseases conveyable by water.

Dr. Willoughby said he was decidedly opposed to the Welsh scheme. He could not view entirely without misgiving further abstraction of the deep water of the London basin by the sinking of wells. The store which had been accumulating for ages would in time be reduced, if the additions to it were less than the quantities taken away. But if we had to go farther afield, there was one source of supply which had never yet been adequately recognized. He referred to the fact that along the coasts large quantities of water found their way to the sea by underground fissures, by the tapping of which great stores of water might be secured.

Mr. Rumsby was in favour of the Welsh scheme, believing that it would secure a purer supply of water, at less cost in the long run, than could be obtained from the Thames or the Lea. He thought that even somewhat peaty water from the Welsh watersheds was preferable to the microbe-abounding waters of the Thames or the Lea.

The Chairman said it had been abundantly proved that the filtration of water, as now practised in London, gave the inhabitants a most admirable supply; and there was no strong evidence to show why we should go to the enormous expense of bringing water from Wales. As to the bogey of bacteria, it was well known the bacteria were kept in check very much by sunlight and filtration, and he should prefer that we should improve the means already at hand, and not adopt the Welsh scheme.

The discussion closed with votes of thanks to the author and reader of the paper, as well as to the Chairman.

GRAND JUNCTION WATER-WORKS COMPANY.

A Special General Meeting of the proprietors of this Company was held on Wednesday, at the Offices, South Molton Street, W., under the presidency of Mr. F. Tendron, to consider the Bill proposed to be introduced into Parliament for improving and facilitating intercommunication between the mains and works of the Metropolitan Water Companies.

The Secretary (Mr. J. Goodwin) having read the notice calling the meeting,

The Chairman stated that the Bill was brought forward by all the

London Water Companies. He was quite sure the proprietors would approve anything that was done, not only in the general interests of the Water Companies, but also for the good of the public—and especially when the object in view was to prevent any portion of the districts of any one of the Companies from suffering seriously in case of accident or of an extraordinary drought like that which they had to encounter in the past year, and which so seriously affected East London. There was a strong desire on the part of the Local Government Board that the portion of the work that fell on the Grand Junction Company should be pushed on at once; and there was a clause in the Bill which would relieve the Company from any responsibility for work which they had to do at the present time, and in doing which it might to any extent exceed the present powers of the Company. The measure would in all probability have the support of the Local Government Board; and there was no doubt in the minds of the Directors that the Bill would be looked upon as a right action on the part of the Companies in the discharge of their duties to the great public of London. He concluded by moving a resolution approving the Bill "subject to such additions, alterations, and variations as Parliament may think fit to make therein, and as the Directors shall approve."

The Right Hon. Lord KNUTSFORD seconded the motion.

Mr. MAKINS asked whether the Bill which the Government were promoting for a similar object would affect the Bill of the Companies.

The CHAIRMAN could not answer this question, because they had merely seen what had been stated in the Queen's Speech. Whether the Government Bill would be the same in principle as that of the Companies, or what the Government intended doing, they could not say at present. He added that the Bill before the meeting provided for the division of the interest on the stock raised between the various Companies in certain proportions according to the value of their respective water-rentals.

Mr. MAKINS understood the Chairman to state that the clause in the Bill referred to, as to the Company exceeding their powers with respect to expenditure, was with the consent of the Local Government Board or the Government.

The CHAIRMAN: At the request, we may say, of the Local Government Board; and therefore, in honour, the Government are bound, whatever Bill comes forward, to see that the Company are indemnified against the consequences of any action or expenditure they may incur at the present time. They might take it for granted that the Directors would not have done what they had done, and what they were doing, in this matter unless it had been at the desire of the Government; but the desire was readily complied with by the Company, because they felt the absolute necessity of doing everything possible to prevent East London from suffering in case of another drought such as that passed through last year—though according to experience such a year was not due for another century.

The resolution was unanimously carried; and the proceedings then terminated.

THE POLLUTION OF RIVERS.

A Deputation from various District Councils in the Thames watershed waited on the Conservators on Monday last week, at their offices on the Victoria Embankment, on the subject of the exercise by them of their powers under the Thames Conservancy Act, 1894, for preventing the pollution of the river. Sir F. Dixon-Hartland, M.P. (the Chairman), and a number of members of the Conservancy Board were present. Viscount Valentia, M.P., in introducing the deputation, said that it consisted of representatives from the District Councils in the counties of Berkshire, Buckinghamshire, Hertfordshire, Gloucestershire, Oxford, Surrey, and Wiltshire, who, while being fully impressed with the importance of the Thames being preserved from contamination by drainage or other impurities, thought that, in those cases where pollution of minor streams occurred, which was not likely to affect the purity of the main river, owing to the water becoming purified by the natural process of filtration, the Councils should not be called upon to incur expenditure beyond the means of the localities concerned. The object of the deputation was to suggest that the requirements of the Conservators might be met by instructions to their inspectors to take their samples only at the outfall of the brooks and minor tributaries into the larger streams or the main river. They also thought that the District Councils should have notice sent to them of the time and place where such samples would be taken, in order that they might secure a comparative analysis. Mr. White, Chairman of the Headington Rural District Council, Oxfordshire, and Mr. Harry Bevir, Clerk to the Cricklade and Wootton Bassett Rural District Council, having offered some remarks, Sir F. Dixon-Hartland, in reply, stated that the powers vested in the Conservancy Board affected about 100 District Councils; and, of course, it was the object of his colleagues and himself to act honestly and considerately towards the whole of those bodies. This was not the first deputation they had received. In 1896 one waited on them, headed by Lord Jersey; and he was pleased to say that the gentlemen who formed it went away satisfied with the explanations given to them. He had to point out to the present deputation, as he had done to the previous one, that the Conservators were bound to see that the Act of 1894 was complied with. They had no power to exempt any Council from its provisions; but, whenever they found that an attempt was being made to carry out what the law demanded, they not only avoided exercising any undue pressure, but, on the contrary, rendered all the help they possibly could. The Board were always quite willing to let Councils know where and when samples would be taken by their inspectors. They did not give them three or four days in which to alter existing facts, or do anything to purify the water. They were, however, quite ready to give notice in the morning that, at such and such a time during the day, their inspector would take samples from a given place. Since 1894 the purity of the water of the Thames had been improved by one-third. Pollutions had been diverted from 362 places above the water intakes, and this from a district with nearly 500,000 people. He thought, from what he had said, it would be admitted that the Conservancy Board had succeeded in doing an important work; and that, in carrying out their duties, they were as considerate as, in view of their responsibility to the public, they had any right to be.

On Tuesday, a conference, convened by the Council of the Sanitary Institute, to consider the subject of river pollution and the necessity for further legislation in the matter, was held in the rooms of the Institute at the Parkes Museum, Margaret Street, W. The chair was occupied by Sir F. Sharp Powell, M.P., who said they must all recognize the injury done to the public health, especially the health of the working classes, by the state of many of our rivers. The subject had already occupied the attention of Parliament; but the law on the question was at present unsatisfactory. The time had now come for a full and comprehensive reform. Dr. Childs moved a resolution to the effect that local Sanitary Authorities should conduct regular inspections and examinations of water, and for this purpose should have free access to any land and premises from or through which water is supplied for domestic purposes. Mr. Willis Bund (Chairman of the Worcestershire County Council) moved, as an amendment, that "County Councils" should be substituted for "Sanitary Authorities." Mr. Hobhouse, M.P., thought the officers of the Sanitary Authorities as well as of the County Councils should have the suggested powers; and the resolution was eventually carried in an amended form—the words "local Sanitary Authorities" being deleted, and "officers of local Sanitary Authorities and County Councils" substituted. Resolutions were also passed to the effect that special Water Authorities should be appointed for each group of gathering-grounds in the kingdom, in addition to, but not superseding, the officials of the several Councils; and that wilful or negligent pollution of any water supply should be treated as a penal offence. Sir J. Hibbert moved that the conference should approve and support the Rivers Pollution Prevention Bill to be introduced into Parliament during the present session by Sir F. Sharp Powell; and the motion was carried after some discussion. It was further decided to communicate to the Local Government Board the resolutions passed by the conference.

NOTES FROM SCOTLAND.

From Our Own Correspondent.

Saturday.

"Municipal murders" is a strong expression to employ, yet it was used in the Glasgow Town Council by Bailie Battersby, when speaking this week upon the subject of the fixing of stop-cocks upon gas service-pipes. Bailie Battersby is perhaps to be excused for the strength of his language, for in the Renfield Street fire, which he referred to, a son of his was one of the victims. The subject was introduced by a question about the examination of old gas-pipes, to which Mr. R. M. Mitchell, the Convener of the Gas Committee, replied that four squads of men were continually at work examining gas-pipes, and, where necessary, repairing them. Now I scarcely think this was the answer which the gentleman expected, because his question was put "in view of recent gas explosions, some of them of a serious character;" and therefore I take it that what he was thinking of was gas-pipes and fittings inside the houses, whereas the four squads of men are mostly engaged on street work. Street inspection and repair is most valuable, and house-to-house inspection would be equally so; but it is not necessary where there is occupation, because the occupants of the house may be expected to call attention to escaping gas. Nearly every case of disaster is found to occur where there are houses which are unoccupied, or where gas is not used. It might be a question for the Committee to consider whether some sort of inspection could not be made of the gas-fittings in such places; and if it were found that the use of gas had been altogether given up in a tenement, a stopcock could be put on at the street, which would prevent gas getting into the building. Cases where the use of gas might be only partially given up in a tenement would be more difficult to deal with; but the same rule would apply. Where dwellings were occupied, the inhabitants would, in nearly every case, protect themselves. For the inspection of uninhabited houses, the Gas Department would require the co-operation of house factors, who, it might be for a consideration, could keep them informed when houses became vacant. There would be a weakness in this arrangement, in respect that in the poorer districts, where almost all the accidents occur, houses are always being vacated, but may be only empty for a week. It might be, then, that a quarterly or half-yearly inspection of the books of house factors, with a view to discovering what houses had stood vacant for a considerable period, would suffice. There is this always, as a further weakness of any arrangements which may be made, that in the poorer districts the most objectionable custom prevails of sub-dividing houses into dwellings of one or two apartments; and in such cases, of course, no system of stopcocks which can be devised would be workable. It is a subject from which it is impossible to wholly eliminate risk. It can only be lessened; and the lessening is, from circumstances which the Gas Committee are not responsible for, all the more difficult in the poorest localities. The poor have many risks to take, on account of their poverty; and this is one of them.

The Corporation had appointed a Special Sub-Committee to consider the subject of stopcocks. The Sub-Committee procured the following joint report from the Gas Engineer (Mr. W. Foulis), the Master of the Fire Brigade (Mr. W. Paterson), and the Master of Works (Mr. J. Whyte): "On all the larger supply-pipes leading into buildings, and on service-pipes 1½ inches in diameter and upwards, which have been laid during the last twenty years, stopcocks are fixed in the footpath or street. Service-pipes under 1½ inches in diameter, leading into tenements or buildings which have been fixed during the last six years, or since the Police Act of 1892 came into force, are fitted with stopcocks fixed in a convenient position. These stopcocks are seldom, if ever, used—and that only after it has been ascertained that all the stopcocks in the houses have been shut off. This precaution is absolutely necessary, as, if the gas were shut off while the interior stopcocks were left open, it might lead to serious results on the gas being again turned on. In the case of fire occurring in a building or tenement, the gas cannot, without serious inconvenience, be shut off during the initial stages of the fire, as it is absolutely necessary that the firemen and others should have light to see their way about the premises. The stopcocks where underground are, of necessity, placed in the footpath close to the building; and during the last twenty years there have only been one or two cases in which it has been possible to get at these stopcocks while a fire was in progress. The quantity of gas escaping from the ordinary service-pipes is seldom, if ever, sufficient to cause inconvenience or to increase the extent of a fire; and in the case of the larger service-pipes, the safest and most

practical method of cutting off the supply of gas is to cut and plug the main-pipe at each end of the building affected. This is the course usually followed. The cost of putting stopcocks on the service-pipes not already fitted would be very great; and, taking everything into consideration, we do not think that any practical advantage would be secured thereby. It is right to mention that a number of experienced men are kept on duty at the workshops of the Gas Department day and night, who are in telephonic communication with the fire office; and one man from the gas office is stationed at the central fire office during the night. These men are at the call of the firemaster, and attend all fires to carry out his instructions. A suggestion seems to have been made that valves should be fixed on the mains in each street; but it would be quite impracticable to use such valves, if they were fixed. The inconvenience and risk of shutting the gas off a street and putting every house in darkness, especially during the excitement caused by a fire, would be so great that no one with a knowledge of the circumstances would dare to do it." This report came before the Town Council on Thursday; and its adoption was moved. It was then that Bailie Battersby made the remark to which I have referred. He thought that a moral responsibility for those deaths rested somewhere; and he made the assertion, for which there is no evidence, but only gossip, that in the case of the Renfield Street fire, the men lost their lives on account of an explosion of gas. I think such a notion is scarcely credible. A building burning from top to bottom is scarcely the place where an explosion of gas of such magnitude as would bring down a wall four storeys high would occur. Bailie Battersby moved that the Gas Committee should reconsider the matter. In the course of a short discussion on the subject, Bailie Fife said the cost was never an element which the Gas Committee took into consideration in connection with any improvement that was necessary; and he thought that the report might be taken back by the Committee. Mr. Mitchell agreed to take it back for further consideration.

There is to be an International Exhibition in Glasgow in 1901, of some pretension; and the Corporation Gas Department have agreed, in order to assist the undertaking, that in all cases gas used by exhibitors of appliances and machines for the use of gas—such as lighting, heating, and cooking, gas-engines, &c—be given free; and that all gas used for other purposes be paid for by the Executive Committee of the Exhibition at the then current rate. The Committee also recommend that the pipes necessary to supply gas up to the general meters be laid at the expense of the Gas Department.

The Paisley Corporation had before them on Tuesday a minute of the Gas Committee, containing a report by the Gas Engineer (Mr. G. R. Hislop) upon the proposed extensions at the gas-works, and stating that the Committee had resolved that the extensions be proceeded with. The Committee recommended that, with a view to the providing for these extensions, and others which may be necessary during the next five years, application should be made to the Secretary for Scotland, for a Provisional Order empowering them to borrow £25,000. When the recommendation came before the Corporation, ex-Provost Clark moved that they should not make such an application. He had no intention, he said, of discouraging any necessary extensions at the gas-works; but he was of opinion that, with the price they were paying for gas, and with proper financing, they would be able to get along without these further borrowing powers. The recommendation of the Committee was adopted by thirteen votes to four.

The Gas Committee of the Dundee Town Council met on Tuesday last at the gas-works, as agreed upon, to consider the proposals for the extension of the works. It is intimated that they carefully inspected the plans prepared by the Manager (Mr. W. M'Crae), and also the ground; and that, after discussion, it was resolved to send a deputation of two or three of their number to Glasgow to consult Mr. W. Foulis on the whole subject. If these extensions (provided they are ever completed) should not be in all respects what they ought to be, no one will be able to say that any defect which might exist would be due to want of consideration on the part of the Corporation.

It is somewhat curious that almost precisely the same procedure is being followed in connection with the new gas-works for the Corporation of Perth. The contract for the retort-house portion of the work was given a long while ago to West's Gas Improvement Company; but, on account of the cost of the whole works, when estimated for, being found to be much more than had been anticipated, the Contractors were requested to hold their hand, which they agreed to do. The Commission called in Mr. Foulis, of Glasgow, to advise them as to how to keep the cost within the limits they desired. There have been intimations, from time to time, as to how the negotiations were proceeding; and they appeared to be progressing favourably, if slowly. It seems that West's Gas Improvement Company have sent in a new estimate for the contract. In connection with it, Mr. West was in Perth recently, and saw the Works Committee of the Gas Commission. He explained what had been done, and urged that the work should be proceeded with at once, as the great delay was prejudicial to his firm. The Convener of the Committee (ex-Bailie Cuthbert) said that he had shown the specifications to Mr. Foulis, who desired that the chimney of the retort-house should be raised to 100 feet in height, and should be extended in diameter to 7 feet. Mr. West was of opinion that there was no necessity for such an increase in size; but he offered, without any addition to the price, to heighten the chimney to 85 feet, and to increase its diameter to 5½ feet. The Committee resolved to lay this offer before Mr. Foulis; and, if he agreed to it, West's Gas Improvement Company should be instructed to at once proceed with the contract.

The Works Committee of the Perth Gas Commission on Monday proposed a modification of their coal contract, the like of which is not often heard of. They have dispensed with the use of the oil plant, and they find it necessary to purchase 2000 tons of cannel. But, to add 2000 tons of cannel to the quantity of coal estimated for, would disturb their financial arrangements; and so it was recommended by the Works Committee that 2000 tons of splint should be pushed out of this year, and into the next. The Committee gave the Manager power to purchase 2000 tons of Niddrie and Benhar cannel. The recommendation of the Committee was laid before the Commission on Monday; and it was opposed by Bailie Wright, the ex-Convener of the Works Committee, not on the proposal to purchase cannel, but on the proposal to restrict the splint. He was able

GAS AND WATER COMPANIES' STOCK AND SHARE LIST.

Referred to on p. 431.

Issue.	Share.	When ex-Dividend.	Dividend or Dividend & Bonus.	NAME.	Closing Prices.	Rise or Fall in Wk.	Yield upon Investment.	Issue.	Share.	When ex-Dividend	Dividend or Dividend & Bonus.	NAME.	Closing Prices.	Rise or Fall in Wk.	Yield upon Investment.
£			p. c.	GAS COMPANIES.			£ s. d.	£			p. c.	GAS COMPANIES.			£ s. d.
590,000	10	Oct. 13	10½	Alliance & Dublin 10 p. c.	22½—23½	..	4 9 4	150,000	5	Nov. 30	8	Oriental, Ltd. . . .	7½—7¾	..	5 3 3
100,000	10	,,	7½	Do. 7 p. c.	16—17	..	4 8 3	135,000	5	,,	8	Do. New, £4 10s. pd.	6½—6⅝	..	5 6 8
800,000	100	Jan. 3	5	Australian 5 p. c. Deb. .	104—106	..	4 14 4	15,000	5	,,	8	Do. do. 1879, £1 pd.	1¼—1⅜	..	4 11 5
900,000	5	Nov. 11	6	Bombay, Ltd. . . .	6½—7	..	4 5 9	60,000	5	Sept. 29	7	Ottoman, Ltd. . . .	5—5½	..	6 6 2
40,000	5	,,	6	Do. New, £4 paid .	4⅝—5¼	..	4 11 5	500,000	100	Dec. 1	6	People's Gas | 2nd Mtg. of Chicago | Bonds .	102—106	..	5 13 2
880,000	Stk.	Aug. 12	12	Brentford Consolidated	280—285	..	4 4 3								
240,000	,,	,,	9	Do. New . . .	312—317	..	4 2 11	848,070	10	Oct. 13	6	River Plate Ord. . . .	9⅝—10½	..	5 17 1
50,000	,,	,,	5	Do. 5 p. c. Pref. .	140—145	..	3 9 0	350,000	Stk.	Dec. 30	4	Do. 4 p. c. Deb. .	101—103	+1	3 17 8
159,375	,,	Dec. 15	4	Do. 4 p. c. Deb. .	128—133	..	3 0 2	250,000	10	Sept. 29	10	San Paulo, Ltd. . . .	16—17	..	5 17 8
220,000	Stk.	Sept. 15	11½	Brighton & Hove Orig. .	267—272	..	4 4 7	135,000	Stk.	Sept. 15	10	Sheffield A.	242—245	..	4 1 8
226,320	,,	,,	8½	Do. A. Ord. Stk. .	197—200	..	4 5 0	209,053	,,	,,	10	Do. B.	242—245	..	4 1 8
933,500	Stk.	Aug. 31	5	Bristol, 5 p. c. max. .	125—130	..	3 16 11	447,427	,,	,,	10	Do. C.	242—245	..	4 1 8
420,000	20	Sept. 29	10	British	48—50	..	4 0 0	5,600,000	Stk.	Feb. 10	5⅓	South Metrop., 4 p.c. Ord.	144—147*	+1	3 12 6
50,000	10	Aug. 13	12†	Bromley, Ord. 10 p. c. .	26—28	..	4 5 9	1,460,000	,,	Jan. 13	3	Do. 3 p. c. Deb. . .	101—103	..	2 18 3
75,000	10	,,	9†	Do. 7 p. c. . . .	20—22	..	4 1 10	—	—	—	—	Tottenham and | A. .	—	—	—
500,000	10	Oct. 13	6	Buenos Ayres (New) Ltd.	9⅜—10½	..	5 17 1	—	—	—	—	Edmonton | B. .	—	—	—
220,000	Stk.	Dec. 30	4	Do. 4 p. c. Deb. .	100—102	+1	3 18 5	182,380	10	Dec. 30	5	Tuscan, Ltd.	9½—10½	..	4 15 3
150,000	20	July 14	8½	Cagliari, Ltd. . . .	29—30	..	5 10 0	149,900	10	Jan. 3	5	Do. 5 p. c. Deb. Red.	99—101	..	4 19 0
100,000	10	Sept. 29	7	Cape Town & Dis., Ltd.	14—15	..	4 13 4								
50,000	50	Nov. 2	6	Do. 6 p.c. 1st Mort.	57—59	..	5 1 8								
550,000	Stk.	Oct 13	13⅓	Commercial Old Stock .	313—317	..	4 5 2					WATER COMPANIES.			
200,750	,,	,,	10⅔	Do. New do. .	242—247	..	4 5 0								
200,750	,,	Dec. 15	4½	Do. 4½ p. c. Deb. .	145—150	..	3 0 0	746,184	Stk.	Dec. 30	11	Chelsea, Ord.	320—325	..	3 7 8
800,000	Stk.	Dec. 15	10	Continental Union, Ltd.	200—205	..	4 17 7	150,000	,,	,,	5	Do. 5 p. c. Pref. .	168—173	..	2 17 10
200,000	,,	,,	7	Do. 7 p. c. Pref. .	187—192	..	3 12 11	160,000	,,	,,	4½	Do. 4½ p. c. Pref. '75	150—155	..	2 18 1
51,600	Stk	Aug. 31	14	Croydon A 10 p. c. . .	305—310	..	4 10 4	175,785	,,	Sept. 29	4½	Do. 4½ p. c. Deb. .	157—162	..	2 15 7
168,400	,,	,,	11	Do. B 7 p. c. . .	255—265	..	4 3 0	1,730,560	Stk.	Oct. 13	7	East London, Ord. . .	218—223	..	3 2 9
555,000	Stk.	Aug. 12	5½	Crystal Palace Ord. 5 p. c.	130—135	..	3 17 9	654,740	,,	Dec. 30	4½	Do. 4½ p. c. Deb. .	157—160	..	2 16 3
60,000	,,	,,	5	Do. 5 p. c. Pref. .	142—147	+2	3 8 0	390,000	,,	,,	3	Do. 3 p. c. Deb. .	101—103	..	2 18 3
486,090	10	Jan. 27	11	European, Ltd. . . .	22½—23½	+½	4 13 7	700,000	50	Dec. 15	7½	Grand | 10 p. c. max. .	112—115	..	3 5 3
354,060	10	,,	11	Do. £7 10s. paid .	17—18	..	4 11 9	310,000	Stk.	Sept. 29	4	Junction | 4 p. c. Deb. .	138—143	..	2 15 11
14,993,075	Stk.	Feb. 10	4⅒	Gas- | 4 p. c. Ord. . .	115—117*	−2½	4 3 9	708,000	Stk.	Feb. 10	14	Kent	360—365*	..	3 16 9
2,900,000	,,	,,	3½	light | 3½ p. c. max. . .	100—102*	..	3 8 8	160,000	,,	,,	7	Do. New, 7 p. c. max. .	210—215*	..	3 5 1
3,739,735	,,	,,	4	and | 4 p. c. Con. Pref.	126—128*	+1	3 2 6	1,043,800	100	Dec. 30	10½	Lambeth, 10 p. c. max. .	297—302	..	3 9 6
3 843,975	,,	—	—	Coke | 3 p. c. Con. Deb.	101—103	..	—	406,200	100	,,	8	Do. 7½ p. c. max. .	230—235	..	3 8 1
70,000	10	Nov. 11	8	Hongkong & China, Ltd.	14—15	..	5 6 8	850,000	Stk.	Sept. 29	4	Do. 4 p. c. Deb. .	138—143	..	2 15 11
3,900,000	Stk.	,,	10	Imperial Continental .	228—233	..	4 5 10	500,000	100	Feb. 11	12½	New River, New Shares	430—435*	..	3 3 2
376,400	100	Feb. 1	4	Do. 4 p. c. Deb. Red.	98—101	..	3 19 3	1,000,000	Stk.	Jan. 27	4	Do. 4 p. c. Deb. .	137—142	..	2 16 8
473,600	Stk.	Feb. 10	3½	Do. 3½ p. c. Deb. ,,	102—105*	..	3 6 8	902,300	Stk.	June 29	7½	South- | Ord. . . .	200—205	..	3 13 2
75,000	5	Nov. 30	6	Malta & Medn., Ltd. .	5—5½	..	5 9 1	126,500	100	,,	7½	wark | 7½ p. c. max..	190—195	..	3 16 11
560,000	100	Oct. 1	5	Met. of | 5 p. c. Deb.	112—114	..	4 7 9	489,200	Stk.	,,	5	and | 5 p. c. Pref.	168—171	..	2 18 6
250,000	100	,,	4½	Melbourne | 4½ p. c. Deb.	107—109	..	4 2 7	1,019,585	,,	Oct. 13	4	Vauxhall | 4 p. c. A Deb.	138—143	..	2 15 11
541,920	20	Nov. 11	5	Monte Video, Ltd. . .	15—16	..	6 5 0	1,155,066	Stk.	Dec. 15	10	West Middlesex . . .	300—305	..	3 5 7
617,946	Stk.	Aug. 31	9½†	Newc'tle & Gatesh'd Con.	232—236	..	4 2 8	200,000	,,	,,	4½	Do. 4½ p. c. Deb. .	159—162	−1	2 15 7
264,855	Stk.	Dec. 30	3½	Do. 3½ p. c. Deb. .	107—110	..	3 3 8	200,000	,,	Sept. 15	3	Do. 3 p. c. Deb. .	102—105	..	2 17 2

* Ex div.

† Next dividend will be at this rate.

to show that if the splint coal were not taken till after April 30, the Commissioners would have to pay 1s. per ton more for it, which would represent a loss to them of £100. The proposal of the Works Committee was disapproved of by 16 votes to 2; whereupon Mr. Cuthbert, taking the decision as a vote of want of confidence in him, tendered his resignation of the convenership of the Committee. Of course, I have not full information before me; but it does seem to me a matter of doubtful advantage to buy dearer coal in substitute of cheaper, with the knowledge that in addition to paying more for the cannel in the meantime, the Commission would, two months hence, have the price of the splint raised upon them by £100.

We in Scotland have escaped the violent storms which have raged in the South, and have, instead, had a number of exceedingly spring-like days. High tides have prevailed, and have done some mischief. So far as gas-works are concerned, the only damage I have learned of is at Monifieth, where part of the site of the works which are being erected there has been washed away by the sea.

Monifieth is a freshly created burgh, near Dundee; and in it there is a newly formed Gas Company, which was promoted by leading inhabitants after they failed to get the community to adopt the Burghs Gas Supply Act. Ever since the formation of the Company, there has been bad feeling in the Police Commission, some of the members of which, without any apparent reason, have endeavoured to upset the arrangements which have been made between the Commission and the Company, as well as to discredit the public spirit of those who are connected with both bodies. There have been repeated scenes on this account at the meetings of the Police Commissioners. The last was on Tuesday night. After a pretty long discussion, the Commissioners, by 5 votes to 3, adopted a resolution to the effect that the lamp-posts, newly erected, be removed from the streets, and placed in the Commissioners' yard.

The Stirling Gas Company appealed against the valuation of their works and plant having been raised by the Magistrates of the burgh from £1700 to £2685. They asked for a reduction to £1880. The appeal was heard by Lord Kyllachy and Lord Stormonth-Darling in Edinburgh, last Wednesday. I was present to see if anything of interest might come out of the situation; but almost nothing did. The only remark of consequence was by the Counsel for the Company, who said that the relations between them and the Corporation were very strained. The Corporation opposed the Company being incorporated last year, and were unsuccessful. He did not know whether or not this had anything to do with the matter; but he maintained that the Magistrates had erred in fixing the valuation too high. The Company claimed deductions from their free revenue in respect of the pension they pay to Mr. Watson, their late Manager, which they consider a legitimate charge upon the works; in respect of stoves; of fire insurance; and of interest upon tenants' floating capital. This they put at £12,500. The Court refused the appeal, because it had not been properly stated. Instead of giving them a ravel of arguments, the case (stated by the Magistrates) should have given the facts found proved, and the grounds upon which they went. If the Magistrates had been asked to state a case properly, and had refused, the Court would have sent the matter back to them, or would have sustained the appeal. This decision would not prevent the Company coming up another year with a properly stated case. There was some talk about the information which the Company gave the Magistrates. Counsel said they had their books in Court, and offered to show them. Lord Stormonth-Darling thought it would have been better if they had put the Manager, or someone, into the witness-box, to speak as to the books. There would then have been information which the Appeal Court could have proceeded upon in determining whether the Magistrates had, or had not, formed an erroneous judgment upon the facts.

CURRENT SALES OF GAS PRODUCTS.

LIVERPOOL, *Feb.* 18.

Sulphate of Ammonia.—A fair amount of business has been done; but makers have offered their production freely, and some further decline in values has to be recorded. The closing quotations are £10 1s. 3d. to £10 3s. 9d. per ton, delivered f.o.b. at the ports. Consumers abroad have been very difficult to move, unless at a further decline; there being speculative sellers for March delivery at below the equivalent of prompt prices. The spot buying has consequently again been mainly for "covering" sales for February delivery. In the forward position, no first-hand business is reported, although the London quotation for February-June delivery has been reduced to £9 18s. 9d. per ton, Beckton terms.

Nitrate of Soda is steady at 7s. 7½d. per cwt. for good, up to 7s. 9d. per cwt. for refined, quality.

LONDON, *Feb.* 18.

Tar Products.—A good deal of benzol is changing hands; but prices do not respond to the noticeable increased activity. On the contrary, nineties are quoted slightly less. The steady demand for solvent and heavy naphthas continues; and it looks as if these bye-products will survive the extraordinary depression which has come over the lighter productions from tar. Creosote keeps firm with a good demand; and to show the extraordinary condition of trade, many distillers are running the whole of their early products through their stills into creosote. Crude naphtha, as a matter of fact, is no better value than good creosote oil. Anthracene is still without interest; but a lessened production all round is bound sooner or later to bring about a change in this article. Pitch is steady, with an inclination to better prices. A large business is being done; and with the further advance in the cost of coal, and other fuel, it is just possible that pitch may see better prices before the end of the season.

Values are as follows: Tar, 13s. to 19s. Pitch, east coast, 24s. 3d.; west coast, 22s. 3d. Benzols, 90's, 7½d.; 50's, 8½d. Toluol, 1s. Solvent naphtha, 1s. 1½d. Heavy naphtha, 1s. 2d. Crude, 30 per cent., naphtha, 3½d. Creosote, 3¼d. Heavy oils, 55s. Carbolic acid, 60's, 2s. Creosote salts, 40s. Anthracene, nominal, "A," 4d.; "B," 2¾d.

Sulphate of Ammonia.—Buyers are fighting a little shy, and market quotations are slightly lower. It is possible this is but a temporary depression; but business has been done at a price corresponding to about £10, less 3½ per cent., at all ports. Stocks in makers' hands are light,

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and it is known that large business has been booked by middlemen for spring delivery. The home demand is beginning, and is likely to be a record one this season.

COAL TRADE REPORTS.

From Our Own Correspondents.

Lancashire Coal Trade.—The settlement with regard to the wages question, though in some quarters it is looked upon as conceding an advance in wages which prices do not at present justify, is generally considered a very fair arrangement. The most satisfactory feature is that it practically fixes the basis of wages for the ensuing twelve months; while the advances which are to be granted will come into operation at the most convenient periods for the coal trade. The first portion of the advance, conceding to the men 5 per cent. above the present rate, does not commence until April, when the inquiries for gas-coal contracts begin to be sent out; and the opinion generally expressed is that the increase in wages will justify collieries in holding out for correspondingly higher prices on contracts for gas coal. To a similar extent this will also apply to the large contracts for locomotive fuel, which come upon the market about the same time. Of course, it is too early at present to obtain any reliable indication as to the prices collieries are likely to fix for next year's gas coal contracts; but so far as can be gathered, it is not improbable they will ask a further advance of from 9d. to 1s. over last year's rates, and a similar advance on locomotive fuel. The second portion of the advance in wages, which comes into operation in October, will still further operate in tending to check any easing down in prices that usually takes place during the summer months on the better qualities of round coal; and it seems tolerably certain that the rates now current will be generally maintained, with a probability that there may be some further advance when the ensuing winter season's demand sets in. As to the general condition of trade, it remains very much as reported last week. List rates are fully maintained at 12s. to 12s. 6d. per ton at the pit for best Wigan Arley, 10s. 6d. to 11s. for Pemberton four-feet and seconds Arley, and 9s. 6d. to 10s. for common house coal. Other descriptions of round coal, continue in brisk request, and very firm at the full prices that have been ruling recently; good ordinary steam and forge coals readily fetching 8s. 6d. to 9s. per ton at the pit on inland sales. Most of the Lancashire collieries remain very firm at the full prices quoted of late; common sorts averaging 4s. 9d. to 5s. per ton at the pit, medium 5s. 3d. to 5s. 9d., and best 6s. 3d. to 6s. 9d. For shipment, there is not more than a moderate inquiry; but as there are no surplus supplies which are being pushed on the market, prices are strongly maintained. They average 9s. 6d. per ton for common steam coal at the Garston Docks, 10s. at the High Level, Liverpool, and 10s. to 10s. 6d. at the Partington tips of the Manchester Ship Canal.

Northern Coal Trade.—There has been rather more irregularity about the coal trade of the North; the demand having increased for steam coals, while for some classes of Durham coals there has been a falling off which has been reflected in the price. In best Northumbrian steam coals, the price is now about 11s. per ton f.o.b. for prompt delivery; but for forward delivery there are higher quotations. Second-class steam coals are about 9s. 9d. per ton, and steam smalls 4s. 9d. In the gas coal trade, the settlement of the contracts for Stockholm at an advance of about 1s. 9d. per ton on the rates that prevailed last year has been followed by the decision in the Bordeaux contracts; and, allowing the usual freight, it is said that a part of these have been allotted at a price that is equal to about 7s. 9d. per ton f.o.b.; though the exact quotation seems a little doubtful as yet. Gas coke is in fuller demand, with little or no alteration in price.

Scotch Coal Trade.—The demand for all classes of coal improves. In the West, the miners are displeased at the refusal of 6d. per day advance, and are holding idle days to discuss what they should do in the circumstances. In Fifeshire, also, the wages question is still an open one. Till now the miners have been working very steadily, and there have been large outputs; but the coal has been eagerly taken up, chiefly to replenish stores which had been let down. The near approach of the shipping season is also leading to inquiries for forward delivery. A miner's wage at the present time is stated to be 6s. 3d. per day; so that there is little likelihood of their securing an advance. They may, however, succeed in dislocating trade, by forcing on a dispute with the coalmasters. The prices quoted are: Main 9s. 3d. per ton f.o.b. Glasgow, ell 9s. 9d. to 10s. 6d., and splint 10s. 6d. The shipments for the week amounted to 148,419 tons—a decrease of 18,605 tons upon the preceding week, but an increase of 39,665 tons upon the corresponding week of last year. For the year to date, the total shipments have been 810,588 tons—an increase of 40,962 tons over the same period of last year.

The Ramsden Water-Works Assessment.—The reservoir and mains of the Ramsden Water Company have hitherto been rated at £336; and the Assessment Committee of the Todmorden Union proposed to increase this by £1784—making the total £2120. Notice of appeal was given against this by the Directors of the Company; but the undertaking had then virtually become the property of the Rochdale Corporation, by whom the appeal would have been carried on. A settlement has, however, been arrived at. The new assessment will be £1320—£984 more than the old one, but £800 less than the amount proposed by the Committee.

Fatal Fire on a Gas-Refuse Barge.—A fire, attended with the loss of two lives, broke out at a quarter-past four last Wednesday morning on the barge *James*, lying in the Regent's Canal alongside the Iceland Wharf. The barge is one of 40 tons, and has been used for the purpose of carrying liquid gas refuse to a factory. A quantity of gas accumulated in the hold, and was ignited when one of the crew lifted the hatchway with a lighted taper in his hand. The immediate result was that the entire barge was fired; and James Baldock (45) and Henry Groodge (21) were terribly burned, and had to be at once removed to a hospital. After the fire was extinguished—by which time the barge had been burned out—the charred remains of a man named Charles Saunter, who was 40 years of age, were found in a crouching position in a corner. Baldock expired on Wednesday night, as the result of his injuries.

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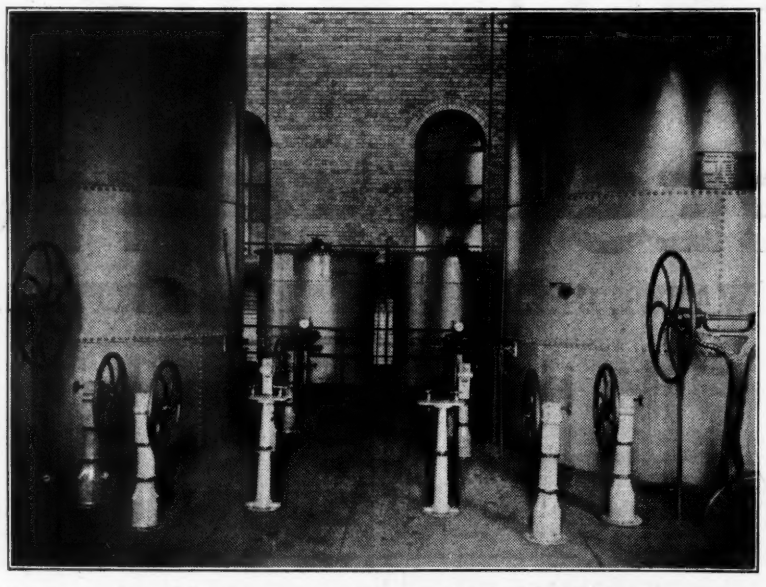

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Bishop's Teignton Water Supply.—A new reservoir for the supply of the village of Bishop's Teignton, near Newton Abbot, was formally opened yesterday week. The reservoir is situated on a sloping piece of land known as Hollow Combe. It has a depth of 7 feet, and is 30 feet wide and 74 feet in length; the capacity being 97,000 gallons. It was stated that the spring which supplies the reservoir had been tested for three seasons, and was found to yield a minimum of 11,000 gallons per day. The reservoir will store about a week's supply for the village. Captain J. G. Templer, who gave the land for the reservoir, performed the ceremony of turning on the water, and stated that the scheme originated with his father. The pressure was tested by the Fire Brigade, and was found more than sufficient to throw water over any house in the village.

Barnet District Gas and Water Company.—The accounts of this Company for the half year ending Dec. 31, which will be submitted to the proprietors at their meeting on Friday, show that the gas revenue was £10,705, the expenditure £6901, and the balance £3804. The water revenue was £10,931, the expenditure £6248, and the balance £4683. There is a sum of £18,886 on the profit and loss account; and out of this the Directors recommend the payment of a dividend at the rate of 9 per cent. per annum on the "A" and "C" stocks, 8 per cent. per annum on the "B" stock, and £6 6s. per cent. per annum on the "D" capital (gas and water stocks). Special interest attaches to this meeting from the fact that a proposition will be submitted to the proprietors to award Mr. Alfred Lass, who, as already announced in the "Journal," has relinquished the position of Secretary and Accountant of the Company, a retiring annuity, in consideration of his long and faithful services.

The Ashton District Council and the Price of Gas.—A report has been laid before the Gas Committee of the Ashton District Council by the Clerk, in which, referring to the working of the gas undertaking, he suggests a substantial reduction in the price of gas. He says it has been the custom, when considering the question of a reduction in the price of gas, not to take into account the amount required for the redemption of loans, which has usually come from the rates; and the credit balance now shown by the accounts would, he thinks, allow of a reduction in the price of 8d. per 1000 cubic feet. This would bring the price down to that charged by the Wigan Corporation to the out-townships—viz., 3s. 6d. He suggests that, if the Committee consider it desirable to make a reduction, that it should not come into operation until the end of the financial year. He further urges that various improvements should be carried out at the works, and advises the calling in of Mr. J. Timmins, or some other competent Engineer. The report was introduced, with the minutes of the Committee, at the meeting of the Council yesterday week, when, referring to the proposed reduction, Mr. Hamilton asked his fellow-members to bear in mind that the undertaking had been materially helped out of the rates; and it should pay its way and its debts to the rates before a reduction was made. Other members held that a reduction would encourage the use of gas, and so help forward the undertaking. The minutes were confirmed; but we do not gather that it is definitely decided to reduce the price to the extent named.

New Joint-Stock Companies.—The following joint-stock companies have lately been registered: The Selsey Gas Lighting Company, Limited, with a capital of £7000, in £1 shares, to establish and maintain gas and electric lighting and power works at Selsey, in Sussex; also to carry on business as coal and coke merchants. '99 Tar Products Sales Committee, Limited, with a capital of £30,000, in £1 shares, to carry on business as dealers in tar, tar products, and all the residual or other products obtained in the manufacture thereof, also as warehousemen, brokers, forwarding agents, insurance agents, carriers, and financiers. The first Directors are Messrs. S. B. Boulton, F. Lennard, C. D. T. Bushell, J. G. Lyon, R. Bird, J. J. Holden, J. B. Butler, and E. A. Brotherton.

The Quality of Carlisle Gas.—Complaints of the quality of the gas supplied by the Carlisle Corporation led the Gas Committee to consult Messrs. W. Sugg and Co., who have reported that the photometer is in perfect order, and that the average illuminating power of the gas is 19·61 sperm candles. The Gas and Water Engineer has also reported to the effect that during January it was 18·63 candles. At the meeting of the Town Council last Tuesday, these facts were recorded in the minutes of the Gas Committee, in which it was recommended that Messrs. Sugg and Co. be instructed to send a photometrist four times during the six winter months, October to March in each year, to test the illuminating power of the gas—such visits to be without notice—and to report thereon to the Committee after each visit. The minutes were passed.

Fatal Accident at the Cambridge Gas-Works.—A few weeks ago, a stoker named Biggs, employed at the Cambridge Gas-Works, sustained injury to one of his arms by coming in contact with a hot iron slice which was being carried past him by the under-foreman. The skin was broken; but no doctor was sent for, nor was the Manager communicated with. It appears that a lotion consisting of linseed oil and lime water was applied; but the wound became worse, and Biggs was taken to Addenbrooke's Hospital on the 9th inst., where he died the following day. The *post mortem* examination showed that death was due to blood poisoning. At the inquest, a verdict of "Accidental death" was returned; the foreman of the Jury saying they thought that all accidents should be communicated to someone in an official position, and that the slices should be dragged along the ground instead of being carried.

A Trial of Incandescent Gas Lighting at Bristol.—With the view of showing the capabilities of the incandescent system of gas lighting, the Bristol Gas Company have, with the sanction of the Local Authority, put up an installation in Cumberland Street, St. James's. They have substituted for the four ordinary street-lamps lanterns of larger size, and, in place of the familiar 5-feet burner of 16-candle power, have put in each of the lamps two No. 4 new Welsbach burners without chimneys, each equal to 100-candle power. These experimental lamps will remain up for two or three months; and they will show to the citizens that the Company can provide a splendid light at about one-quarter the cost of the electric lamps. The tradespeople and others in the street selected are delighted to have the new system, which certainly seems to challenge the electric light in the immediate neighbourhood; one tradesman saying the lamp outside his premises made his shop as light as day.

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We learn that the Basingstoke Gas Company have placed an order with Messrs. Biggs, Wall, and Co., for one of their new rapid manual charging-machines.

The Hebden Bridge and Mytholmroyd Gas and Water Board have placed an order for some large purifiers with Messrs. R. Dempster and Sons, Limited, of Elland.

Messrs. C. & W. Walker, of Donnington, Shropshire, have obtained a contract for the erection of a set of four large cast-iron purifiers for the Ipswich Gas Company.

The contract for the supply of coal to the Stockholm Gas-Works (about 76,000 tons), has been obtained by the Pelton Colliery, Durham. The price is about 1s. 9d. per ton more than last year.

Messrs. John Wright and Co., Limited, have secured the contract to supply gas apparatus for the kitchens of the East Sussex County Lunatic Asylum, Hayward's Heath, consisting of three roasting-ovens, three soup-boilers, two high-pressure circulating boilers, two boiling-tables, &c.

Last Friday evening, the employees of Messrs. W. & B. Cowan, Limited, at their Buccleuch Street Works, Edinburgh, held their twelfth annual festival and assembly in the large hall of the Literary Institute. Mr. J. Hepworth presided, and gave a short address. The proceedings were most harmonious and enjoyable.

The Local Government Board have granted the Pembroke Town Council power to borrow £26,150 for the sewerage of a portion of Pembroke Dock. The Sanitary Committee, who have the supervision of this work, are presided over by Mr. J. H. Silcox, the Secretary and Manager of the Pembroke Docks and Town Gas Company.

West's Gas Improvement Company, Limited, have already a number of contracts in hand for stoking machinery to be completed this year; among them being complete installations for the Bilston, Warrington, Oxford, and Stretford Gas-Works, and an extension of their system at the Beckton station of The Gaslight and Coke Company.

A trades exhibition has recently been held at Widnes, at which Messrs. Richmond and Co., Limited, had an exhibit of gas cooking-stoves, and were successful in hiring out, on behalf of the Corporation, some 20 ordinary cookers and 120 slot cookers. When the foregoing have been fixed, the total number out on hire in the town will be about 737.

Messrs. W. J. Jenkins and Co., of Retford, have just received an order from the South Metropolitan Gas Company to supply and erect two sets of coal breaking, elevating, and conveying machinery for their Rotherhithe station; this being the third order placed in the hands of the firm for similar plant during the past twelve months. They have also received instructions from the Corporation of Birmingham to supply and erect a 5 million cubic feet Livesey washer at their Saltley station.

The 23rd annual dinner of the Newport (Mon.) Gas-Works Benefit Society was held on the 13th inst.—Mr. T. Canning, J.P., Engineer of the Company and Treasurer of the Society, presiding, and Mr. J. Whitefield, the Secretary of the Society, occupying the vice-chair. The latter, in responding to the toast of "Success to the Gas-Works Benefit Society," presented the report, which showed that there had been paid to members for funerals and sickness £137 8s. 6d., and £9 17s. 6d. to members on leaving the works; making a total of £147 6s.—an increase of £43 0s. 7d. over the year ending June, 1897, and of £77 16s. over 1896. There was a balance of £38 1s. in the bank and in the Treasurer's hands at the close of the financial year.

A tradesman of Newmarket has just sent to the Manager and Secretary of the Newmarket Gas Company (Mr. J. H. Troughton) some valuable testimony in favour of incandescent gas-burners, an installation of which was put up in his shop on the 10th of November last year. His gas bill for the quarter was £4 3s. 1d., as compared with £5 8s. 7d. for the corresponding quarter of 1897—a saving of £1 5s. 6d., with better light and a purer atmosphere. Mr. Sheppard, the gentleman in question, expressed his pleasure in testifying to the advantages of the new burners, and asked Mr. Troughton to make his experience of them known in any way he wished. Mr. Troughton very promptly inserted the testimonial in an attractive form in a local paper.

In a paragraph which appears below, brief reference is made to the "Petroleum Industrial and Technical Review." This publication made its first appearance last Saturday, under the editorship of Mr. Paul Dvorkovitz, whose name, as our readers are aware, has for some years been associated with the petroleum industry; and it will be issued fortnightly at the price of 1s. The aim of the Editor will be, as he states in his introductory remarks, to "record the development of the various industries connected with mineral oils in a thoroughly impartial spirit." There are three articles dealing with the petroleum industry of Russia, Grosny, and Galicia in the past year, and others on the petroleum fields of Alsace and the Scottish oil and petroleum trade.

The Kitson Lamp, which is being manufactured by the Kitson Hydrocarbon Heating and Incandescent Lighting Company, Limited, has recently been tried in Sheffield. It consists of an improved Welsbach mantle, an oil-vapourizing tube, supported immediately above the mantle, and receiving heat therefrom, and an oil-supply tube, which serves to convey the mixture of air and oil-vapour to the mantle. The oil-tank and pump are placed at the base of the pillar carrying the lamp. Each lamp is worked independently; but it is claimed that, with one charging, it will burn for ten hours. For each mantle of between 450 and 600 candle power it is stated that the cost of the petroleum will be about ¼d. per hour. The lamp tried was of 1000-candle power.

A rumour has been current to the effect that the Russian Government intends to raise the freight for refined oil from Baku to Batoum, whence the oil is chiefly exported to European and other markets, from 12 copecks to 19 copecks per pood. Any such increase of freight would result in considerable loss and inconvenience to those who have devoted their energies and attention to marketing Russian oil. With the view of ascertaining the truth of the matter, a communication was sent from the "Petroleum Industrial and Technical Review" to the Editor of the Official Journal of the Russian Ministry of Finance, asking him whether or not the rumour was correct; and, in reply, Mr. Paul Dvorkovitz last Friday received the following cable: "Tariff increase Baku Batoum postponed indefinitely."

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[For Illustrated Advertisement, see Feb. 7, p. 338.]

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WANTED, a good Traveller, experienced on London and South rounds.

Apply to CHAS. WILSON AND SONS, Armley, Leeds.

DRAUGHTSMEN. Capable Men wanted.

Apply, by letter only, stating Age, Experience, and Salary wanted, to GILBERT LITTLE, Smethwick, BIRMINGHAM.

WANTED, by a Merchant Firm, a TRAVELLER in Gas Coal and Cannel. Good Salary and Expenses.

Address No. 3211, care of Mr. King, 11, Bolt Court, FLEET STREET, E.C.

WANTED, a reliable Agent for a first- class DUTCH BOG ORE, containing 80-85 per cent. Hydrated Oxide of Iron.

Apply, by letter, to No. 3177, care of Mr. King, 11, Bolt Court, FLEET STREET, E.C.

WANTED, for a medium sized Works near London, a CARBONIZING FOREMAN, used to Engines and Exhausters, and must understand his work. Wages £2 2s.

Applications, in own handwriting, with *copies* of Testimonials (which will not be returned), to No. 3214, care of Mr. King, 11, Bolt Court, FLEET STREET, E.C.

WANTED, an Assistant to the Engineer of a Medium-Sized, but rapidly growing, Gas-Works in the South of England. Salary £75 per annum. One who has had Drawing Office Experience preferred.

Applications, stating Age, Experience, when at liberty, and accompanied by Two or Three Testimonials, to be sent in as soon as possible to No. 3216, care of Mr. King, 11, Bolt Court, FLEET STREET, E.C.

GAS PURIFICATION.

OXIDE OF IRON BOG ORE.

BALE & CO.'S Oxide of uniform quality. SPECIAL FIRE CEMENT, OXIDE PAINTS, OILS, SULPHURIC ACID, &c.

120 and 121, NEWGATE STREET, LONDON, E.C.
Telegrams: "BOGORE, LONDON."

SPENT OXIDE wanted.

BROTHERTON AND Co., Chemical Manufacturers. Works: BIRMINGHAM, LEEDS, and WAKEFIELD.

ENERGETIC Agents or Purchasers wanted for an Apparatus to reduce Pressure. Price 12s. per 1000 on large orders.

Please address "H. 37," care of RUDOLF MOSSE, Ulm a. D., GERMANY.

WANTED, at once, a thoroughly reli- able and competent Man as METER INSPECTOR and MAIN and SERVICE LAYER. No other need apply. State Wages, Age, and References, and when can begin.

J. G. HAWKINS,
Manager.

Gas-Works, Spalding,
Feb. 10, 1899.

NEWTON-IN-MAKERFIELD URBAN DISTRICT COUNCIL.

GAS AND WATER ENGINEER.

THE above Council invite Applications for the position of GAS and WATER ENGINEER.

Candidates must be not less than 24 nor more than 40 years of age, and be competent to make all the necessary Plans and Drawings for the construction of a New Water Pumping-Station, and to supervise the same during erection, and when completed to act as Water Manager also; to make all necessary Plans for such Extensions as may be required from time to time at the Gas-Works, and have a knowledge of the Manufacture of Gas; to carry out the laying of such additional Gas and Water Mains within the District as the Council may direct, and will be required to devote the whole of his time to the duties of the Office.

The salary will commence at the rate of £150 per annum; and the appointment will be subject to Three Months' Notice on either side.

Applications, accompanied by *copies* of not more than three Testimonials of recent date (which will *not* be returned), to be forwarded to the undersigned not later than Saturday, the 25th of February, 1899, endorsed "Gas and Water Engineer."

Canvassing the Members of the Council directly or indirectly will be a disqualification.

W. W. SHIRLEY,
Clerk to the Council.

Town Hall, Earlestown, Lancs.,
Feb. 10, 1899.

WANTED, two Second-hand (15 or 16 feet), PURIFIERS. Good conditior.

DUXBURY AND Co., 16, Deansgate, MANCHESTER.

WANTED, Offers for a large quantity of 4-inch CAST-IRON H and DIP PIPES, and 5-inch to 4-inch ASCENSION-PIPES.

Address No. 3213, care of Mr. King, 11, Bolt Court, FLEET STREET, E.C.

FOR SALE, by Private Treaty—A com- plete WATER GAS PLANT (Loomis System), two GASHOLDERS, SCRUBBERS, &c. Also a Quantity of CAST-IRON PIPES and VALVES.

For full Particulars and permission to inspect, apply, by letter, to No. 3204, care of Mr. King, 11, Bolt Court, FLEET STREET, E.C.

GAS PLANT for Sale—I can always offer NEW and SECOND-HAND GAS APPARATUS, including Retorts and Fittings, Condensers, Exhausters, Scrubbers, Washers, Purifiers, Gasholders, Tanks, Valves, Connections, &c. Also a few COMPLETE WORKS. Compare Prices and Particulars before ordering elsewhere.

J. F. BLAKELEY, Gas Engineer, Ravensthorpe, YORKS.

FOR SALE, cheap—

Two PURIFIERS, 8 ft. square by 4 ft. deep.
Two ,, 5 ft. ,, 4 ft. ,,
One ,, 5 ft. ,, 3 ft. ,,
One EXHAUSTER, 20,000 Cubic Feet per hour.
Two ,, 5000 ,, ,, ,,
Also CONDENSERS, SCRUBBERS, WASHERS, GASHOLDERS and TANKS, VALVES, &c., &c.

Apply to SAML. WHILE AND SON, 60, Queen Victoria Street, LONDON, E.C.

GAS Plant for Sale, cheap to clear—

RETORT IRONWORK, several good Sets.
Six-inch VERTICAL PIPE CONDENSER complete.
Four ANNULAR CONDENSERS, 32 in. by 18 ft.
EXHAUSTERS and ENGINES, several good Sets.
TOWER SCRUBBERS, 5ft. by 20ft., 5ft. by 40ft., & others.
PURIFIERS from 5 ft. square to 12 ft. square.
STATION METERS and GOVERNORS.
GASHOLDERS, 35 ft. by 14 ft. & 50 ft. by 18 ft., perfect.
VALVES of all kinds in Stock.
IRON STORAGE TANKS.

J. FIRTH BLAKELEY & Co., Ravensthorpe, YORKS.

GAS Companies short of Coal or Cannel can be quickly served by The Eveson Coal and Coke Company, Limited, Birmingham. Write for Prices.

FOR SALE—A pair of Valves for Inlet and Outlet Pipes, 10-inch and 12-inch (only used once), by Donkin and Co.

For further Particulars, apply to the Secretary, Gas Company, Newark.

RAMSGATE CORPORATION.
(Gas and Water Department.)

TENDERS FOR FIRE-CLAY GOODS.

THE Gas and Water Committee invite TENDERS for about 620 feet of STOURBRIDGE or other approved quality FIRE-CLAY RETORTS, 23 in. by 16 in., about 19,000 FIRE-BRICKS, TILES, and about 12 Tons of CLAY.

Tenders to be sent in on or before Noon on Monday, the 6th of March, 1899, addressed to the Chairman of the Gas and Water Accounts Committee, Hardres Street, Ramsgate, endorsed "Tender for Fire-Clay Goods."

Specification and full Particulars on application to
William A. Valon,
Engineer.

BOROUGH OF BRIGHOUSE.

THE Town Council are prepared to receive TENDERS for the supply of the following STORES—viz., IRONMONGERY, OIL, PAINTS, &c., WROUGHT-IRON TUBES and FITTINGS, and BRUSHES, required by the Gas Committee during the Year ending March 31, 1900.

Specifications and Form of Tender can be obtained on application at the Gas Engineer's Office, Mill Lane Works, Brighouse.

Sealed Tenders are to be sent in on or before Friday, the 3rd day of March, 1899, addressed to the Town Clerk, Public Offices, Brighouse.

The lowest or any Tender not necessarily accepted.

By order,
James Parkinson,
Town Clerk.

Public Offices, Brighouse,
Feb. 18, 1899.

MANCHESTER CORPORATION GAS-WORKS.

TO TAR DISTILLERS AND OTHERS.

THE Gas Committee of the Corporation of Manchester are prepared to receive TENDERS for the PURCHASE and REMOVAL on the Sliding-Scale Basis of the GAS TAR to be produced at their Rochdale Road and Bradford Road Stations respectively during a period of One Year, commencing from noon on the 31st of March, 1899.

The Committee do not bind themselves to accept the highest or any Tender, and reserve the right to divide the Tenders as they may consider advisable.

Sealed Tenders, addressed to the Chairman of the Gas Committee, and endorsed "Tender for Tar," must be delivered at the Offices of the Gas Department, Town Hall, on or before Thursday, the 17th day of March, 1899.

Full Particulars may be obtained on application in writing to Mr. Charles Nickson, Superintendent of the Department.

By order of the Gas Committee,
Wm. Henry Talbot,
Town Clerk.

Town Hall, Manchester,
Feb. 17, 1899.

MANCHESTER CORPORATION GAS-WORKS.

TAR AND AMMONIACAL LIQUOR.

THE Gas Committee of the Manchester Corporation are prepared to receive TENDERS for the PURCHASE and REMOVAL of the TAR and AMMONIACAL LIQUOR to be produced at their Droylsden Station during a period of One Year from the 31st of March, 1899.

The Committee do not bind themselves to accept the highest or any Tender.

Sealed Tenders, addressed to the Chairman of the Gas Committee, and endorsed "Tender for Tar and Liquor, Droylsden," must be delivered at the Offices of the Gas Department, Town Hall, on or before Tuesday, the 28th day of February, 1899.

Forms of Tender and further Particulars may be obtained on application in writing to Mr. Charles Nickson, Superintendent of the Gas Department.

By order of the Gas Committee,
Wm. Henry Talbot,
Town Clerk.

Town Hall, Manchester,
Feb. 17, 1899.

MANCHESTER CORPORATION GAS-WORKS.

SPENT OXIDE.

THE Gas Committee of the Corporation of Manchester are prepared to receive TENDERS for the PURCHASE and REMOVAL of the SPENT OXIDE, to be produced at their Gaythorn, Rochdale Road, and Bradford Road Works respectively during a period of One Year from the 31st of March, 1899.

The Committee do not bind themselves to accept the highest or any Tender, and reserve the right to divide the Tenders as they may consider advisable.

Sealed Tenders, addressed to the Chairman of the Gas Committee, and endorsed "Tender for Spent Oxide," must be delivered at the Offices of the Gas Department, Town Hall, not later than Ten a.m., on Friday, the 3rd day of March, 1899.

Forms of Tender and further Particulars may be obtained on application in writing to Mr. Charles Nickson, Superintendent of the Department.

By order of the Gas Committee,
Wm. Henry Talbot,
Town Clerk.

Town Hall, Manchester,
Feb. 17, 1899.

BOROUGH OF BARROW-IN-FURNESS.
(Gas and Water Department.)

SUPPLY OF GENERAL STORES.

THE Corporation are prepared to receive TENDERS for the supply of FIRE-CLAY RETORTS and BRICKS, WROUGHT-IRON TUBES and FITTINGS, BRASS COCKS, GAS-METERS, OIL and PAINT, SULPHURIC ACID, LIME, IRONMONGERY, &c., as may be required from the 1st day of April next to the 31st of March, 1900.

Sealed Tenders, on forms to be obtained at the Office of the Manager of the Gas and Water Works, addressed to the Chairman of the Gas and Water Committee, and endorsed "Tenders for Stores," to be delivered at the Town Clerk's Office on or before Tuesday, the 28th inst.

The lowest or any Tender not necessarily accepted.

By order,
C. F. Preston,
Town Clerk.

Town Hall, Barrow-in-Furness,
Feb. 10, 1899.

BOROUGH OF BARROW-IN-FURNESS.

THE Corporation are prepared to receive TENDERS for the Purchase of the surplus TAR produced at their Gas-Works from the 1st day of April next to the 31st day of March, 1900, delivered into the Purchaser's Tank-Waggons at the Gas-Works Siding.

Any further Information may be had on application to the Manager of the Gas-Works.

Sealed Tenders, addressed to the Chairman of the Gas and Water Committee, and endorsed "Tender for Tar," to be delivered at the Town Clerk's Office on or before Tuesday, the 28th inst.

The highest or any Tender not necessarily accepted.

By order,
C. F. Preston,
Town Clerk.

Town Hall, Barrow-in-Furness,
Feb. 10, 1899.

BOROUGH OF DARWEN.

TENDERS FOR FIRE-CLAY RETORTS, BRICKS &c.

THE Corporation are prepared to receive TENDERS for the supply of FIRE-CLAY RETORTS, BRICKS, &c.

Forms of Tender and all Information as to quantities may be obtained on application to Mr. A. H. Smith, Gas Engineer, Darwen.

Sealed Tenders, endorsed "Fire-Clay Retorts, &c.," must be delivered to the undersigned at or before Noon, on Friday, March 3, 1899.

No Tender necessarily accepted.

By order,
Chas. Costeker,
Town Clerk.

Town Clerk's Office,
Darwen, Feb. 13, 1899.

BOROUGH OF DARWEN.

TENDERS FOR PURIFIERS.

THE Corporation are prepared to receive TENDERS for the supply and erection of Two Twin-Lute PURIFIERS, 30 ft. by 25 ft. by 5 ft., Columns, Girders, &c.

Copies of Plans and Specifications may be obtained on application to Mr. A. H. Smith, Gas Engineer, Darwen.

Sealed Tenders, endorsed "Tender for Purifiers, &c.," must be delivered to the undersigned at or before Noon, on Friday, March 3, 1899.

No Tender necessarily accepted.

By order,
Chas. Costeker,
Town Clerk.

Town Clerk's Office,
Darwen, Feb. 13, 1899.

ASHFORD GAS-WORKS.

CONTRACT No. 4.

THE Urban District Council of Ashford (Kent) are prepared to receive TENDERS for EXCAVATING for and LAYING Cast-Iron Main Pipes and Appendages.

Copies of the Specification and Bills of Quantities can be obtained on and after Wednesday, the 22nd day of February, at the Office of the Clerk of the Council, or at the Office of the Engineers, Messrs. Stevenson and Burstal, 38, Parliament Street, Westminster, on payment of One Guinea, which will be returned upon receipt of a *bonâ fide* Tender.

Sealed Tenders, endorsed "Tender Contract No. 4," are to be forwarded to the undersigned not later than Saturday, the 4th day of March, 1899.

John Creery,
Clerk to the Council.

EDINBURGH AND LEITH CORPORATIONS GAS COMMISSIONERS.

TO CHEMICAL PLANT MANUFACTURERS.

THE Commissioners are prepared to receive TENDERS from Manufacturers of Chemical Works Plant for the supply and equipment of PLANT and APPLIANCES for the DISTILLATION OF AMMONIACAL GAS LIQUOR and the PRODUCTION of the various COMPOUNDS OF AMMONIA therefrom.

Full particulars can be obtained upon application to the Chief Engineer and Manager, Mr. W. R. Herring, Gas-Works, Edinburgh.

Tenders to be addressed to the undersigned, and delivered at 25, Waterloo Place, Edinburgh, on or before the 25th day of March, 1899.

The Commissioners do not bind themselves to accept the lowest or any Tender.

James McG. Jack,
Clerk.

25, Waterloo Place, Edinburgh,
Feb. 11, 1899.

BROMPTON, CHATHAM, GILLINGHAM, AND ROCHESTER WATER-WORKS COMPANY.

FOR SALE, STEAM-BOILERS.

THE Directors of the above Company are prepared to receive TENDERS for the purchase of two CORNISH BOILERS, in thorough good order. Length 30 ft., diameter 4 ft. 8 in., Furnace 2 ft. 10 in. Complete with Stop and Blow-off Valves, Gauges, Dampers, Soot-Doors, &c. Working Pressure 50 lbs.; insured and periodically tested to 90 lbs. by The "Vulcan" Boiler Insurance Company of Manchester.

These Boilers may be seen at work at the Company's Pumping-Station, Luton, Chatham.

Sealed Tenders, endorsed "Tenders for Boilers," must be delivered to the undersigned, on or before Monday, the 6th day of March next.

The Directors do not bind themselves to accept the highest or any Tender.

By order,
Godfrey G. Catt,
Secretary.

Brompton, Chatham, &c., Water-Works Offices,
Railway Street, Chatham, Feb. 17, 1899.

BRISTOL WATER-WORKS.

YEO PUMPING-STATION.

THE Directors of the Bristol Water- Works Company are desirous to receive TENDERS for two Pairs of STEAM COMPOUND ROTATIVE BEAM PUMPING-ENGINES, six LANCASHIRE BOILERS, fitted with MECHANICAL STOKERS, two FUEL ECONOMIZERS, and other MACHINERY and APPARATUS, erected complete at their Yeo Pumping-Station, situate at Blagdon, in the County of Somerset.

Drawings may be inspected, and Specifications and Forms of Tender may be obtained, at the Office of the Clerk of Works, Yeo Reservoir, Blagdon, Somerset, and at the Office of Messrs. T. & C. Hawksley, Civil Engineers, No. 30, Great George Street, Westminster, S.W., on payment of Two Guineas (to be returned if a *bonâ-fide* Tender be made), on and after Saturday, the 18th inst.; and Tenders must be delivered at the Office of the Company on or before Ten o'clock in the forenoon of Saturday, the 4th of March next.

The Company do not pledge themselves to accept the lowest or other Tenders.

Alfred J. Alexander,
Secretary and General Manager.

Bristol, February, 1899.

Note.—Uncoloured Photographic Copies of certain of the Drawings may be obtained on application to Messrs. T. & C. Hawksley, on payment of the Photographer's charge therefor.

TOTTENHAM AND EDMONTON GASLIGHT AND COKE COMPANY.

NOTICE is Hereby Given, that the HALF-YEARLY ORDINARY GENERAL MEETING of the Proprietors of this Company will be held at the Company's Offices, Willoughby Lane, Tottenham, on Saturday, the 25th day of February inst., at half-past Three o'clock in the Afternoon precisely, to receive the Report of the Directors and Statement of Accounts for the Half Year ended the 31st day of December, 1898, to declare Dividends, and transact such other Business as the Act of Parliament directs.

The TRANSFER BOOKS for CONSOLIDATED STOCKS will REMAIN CLOSED until the 25th inst.

By order of the Board of Directors,
James Randall,
Secretary.

Offices of the Company:
Willoughby Lane, Tottenham.

BROMLEY GAS CONSUMERS' COMPANY.

NOTICE is Hereby Given, that the ORDINARY HALF-YEARLY GENERAL MEETING of this Company will be held at the "Bell" Hotel, Bromley, Kent, on Thursday, the 23rd day of February inst., at Six o'clock p.m. precisely, to receive the Report of the Directors, the Balance-Sheet certified by the Auditors, to declare a Dividend, and for General Purposes.

Notice is also Given, that at such Meeting a Resolution will be submitted to create FURTHER SHARE CAPITAL, under the Provisions of the Bromley Gas Act, 1879, by the issue of New Ordinary Shares of £10 each, not exceeding in the whole 300 of such Shares, and to authorize the Directors to issue such Shares at such times, upon such terms, and in such manner as they may think fit, subject to the Statutory Conditions of Sale and Issue relating to such Shares.

The TRANSFER BOOKS WILL BE CLOSED from the 9th to the 23rd inst., both days inclusive.

By order of the Board,
Henry W. Amos,
Secretary.

Offices at the Works:
Bromley, Kent, Feb. 8, 1899.

"GAS, AND HOW TO USE IT."

A useful little Brochure, suitable for Distribution among Gas Consumers in the District of any Gas Company, and containing

USEFUL HINTS TO GAS CONSUMERS, A COMPARISON OF INCANDESCENT BURNERS WITH ELECTRIC LIGHT, &c.

BY

J. H. TROUGHTON.

Sample Copies 6d. *each.*

100, £2; 250, £4 10s.; 500, £7 10s.; 1000, £10.

The Pamphlet can be specialized to suit the Price of Gas and other Conditions of supply in any particular District, at a slightly increased Charge.

Prices for larger quantities of the Publisher:
WALTER KING, 11, Bolt Court, Fleet Street, E.C.

SALES BY AUCTION OF GAS AND WATER STOCKS AND SHARES.

MR. ALFRED RICHARDS begs to notify that his AUCTIONS of STOCKS and SHARES in London, Suburban, and Provincial Gas and Water Companies are held MONTHLY, at the Mart, Tokenhouse Yard, E.C.

He also undertakes the issuing by Auction of Gas and Water Stocks and Shares under Parliamentary Powers.

Terms for issuing such Capital, and also for including Gas and Water Stocks and Shares in these periodical Sales, can be obtained on application at Mr. Alfred Richards's Offices, 18, FINSBURY CIRCUS, E.C.

By order of the Directors of the

PLYMOUTH AND STONEHOUSE GASLIGHT AND COKE COMPANY.

MR. ALFRED RICHARDS will Sell BY AUCTION, at the Mart, E.C., on Tuesday, Feb. 28, at Two o'clock, in Lots,—

£10,000 OF ORDINARY STOCK
OF THE
LYMOUTH AND STONEHOUSE GASLIGHT AND COKE COMPANY.

Ranking for a Standard Dividend of 5 per cent., subject to the Sliding-Scale; the last Dividend on similar Stock in the Company having been at the rate of 6½ per cent.

Particulars may be obtained at the COMPANY'S OFFICES, 1, Athenæum Terrace, Plymouth; and of the AUCTIONEER, 18, FINSBURY CIRCUS, E.C.

By order of the Directors of the

HORNSEY GAS COMPANY.

£5676 of FOUR PER CENT. PERPETUAL DEBENTURE STOCK.

MR. ALFRED RICHARDS will Sell THE ABOVE BY AUCTION, at the Mart, E.C., on Tuesday, Feb. 28, at Two o'clock, in Lots.

Particulars of the AUCTIONEER, 18, FINSBURY CIRCUS, E.C.

By order of the Directors of the

HIGWELL, LOUGHTON, AND WOODFORD GAS COMPANY.

MR. ALFRED RICHARDS will Sell BY AUCTION, at the Mart, E.C., on Tuesday, Feb. 28, at Two o'clock, in Lots,

200 £10 SHARES,

Ranking for a Standard Dividend of 7 per cent., subject to the Sliding-Scale; the Dividend on the Company's 7 per cent. Capital having for several Years past been at this rate.

Particulars of the SECRETARY of the Company at the Offices, WOODFORD, and of the AUCTIONEER, 18, FINSBURY CIRCUS, E.C.

GAS STOCKS AND SHARES
IN THE
PORTSEA ISLAND GASLIGHT COMPANY, WANDSWORTH AND PUTNEY GAS COMPANY, WEST HAM GAS COMPANY, AND WALTON-ON-THAMES AND WEYBRIDGE GAS COMPANY.

MR. ALFRED RICHARDS will Sell THE ABOVE BY AUCTION, at the Mart, E.C., on Tuesday, Feb. 28, at Two o'clock, in Lots.

Particulars of the AUCTIONEER, 18, FINSBURY CIRCUS, E.C.

By order of the Directors of the

LEA BRIDGE DISTRICT GAS COMPANY,

£6000
FOUR PER CENT. PERPETUAL DEBENTURE STOCK
AND
1200 £10 SHARES.

Or such less number as will produce, including Premium, the sum of £19,383. The Shares rank for a Standard Dividend of 7 per cent., subject to the Sliding-Scale; the last Dividend on similar Shares in the Company having been at the rate of 8 per cent.

MR. ALFRED RICHARDS will Sell THE ABOVE BY AUCTION, at the Mart, E.C., on Tuesday, the 14th of March, at Two o'clock, in Lots.

Particulars of the SECRETARY of the Company, 3, Jeffreys Square, St. MARY AXE, E.C.; and of the AUCTIONEER, 18, FINSBURY CIRCUS, E.C.

HEATHCOTE GAS COAL.

Rich in Illuminating Power and Yield of Gas. Above the Average in Weight and Quality of Coke. Maintains a High Standard in Residuals.

THE GRASSMOOR CO., LD.
CHESTERFIELD.

BRIGHTON AND HOVE GENERAL GAS COMPANY.

TO THE PROPRIETORS.

NOTICE is Hereby Given, that the ORDINARY HALF-YEARLY GENERAL MEETING of the Proprietors of this Company will be held at the Company's Offices, No. 5, Great Winchester Street, London, on Friday, the 10th of March, 1899, at Two o'clock in the afternoon precisely, to receive the Report of the Directors and the Accounts of the Company for the Half Year ended the 31st of December, 1898, to declare Dividends, to elect two Directors, to appoint a Special Auditor, and for other purposes.

The TRANSFER BOOKS of the Company WILL BE CLOSED from the 25th of February to the 10th of March, both days inclusive.

By order,
ERNEST L. BURTON,
Secretary.

5, Great Winchester Street,
London, E.C., Feb. 17, 1899.

WEYMOUTH CONSUMERS' GAS COMPANY.

ISSUE OF £6850 3½ PER CENT. PERPETUAL DEBENTURE STOCK.

NOTICE is Hereby Given, that the Directors of the Weymouth Consumers' Gas Company are prepared to receive TENDERS for £6850 PERPETUAL DEBENTURE STOCK (created under the Provisions of the Weymouth Consumers' Gas Act, 1897), to bear Interest at the rate of 3½ per cent. per annum.

The Stock will be issued free of Registration expenses.

Tenders must be delivered at the Company's Offices, 71, St. Thomas Street, Weymouth, not later than Ten a.m. on Tuesday, the 7th day of March, 1899.

Particulars and Conditions, together with Form of Tender, may be obtained at the said Offices, or will be forwarded upon application.

By order of the Board of Directors,
JAMES LOWE,
Manager and Secretary.

Gas Offices: 71, St. Thomas Street,
Weymouth, Feb. 21, 1899.

THE Acetylene Illuminating Company, Limited, 63, Queen Victoria Street, London, E.C., GIVE NOTICE that they hold the BRITISH PATENT RIGHTS for the MANUFACTURE OF CALCIUM CARBIDE by means of the electric furnace, that they are bringing an action against the Midland Acetylene (Parent) Syndicate, Limited, to restrain them from so manufacturing that product, and that they intend in the future to bring actions against all infringers of these Patents and all purchasers or users of Carbide of Calcium made in infringement of the same.

NOTICE.

THE Acetylene Illuminating Company, Limited, having published and issued an advertisement or circular claiming that they hold the British Patents for the Manufacture of Calcium Carbide by means of the Electric Furnace, we guarantee to indemnify anyone who buys Carbide from us against any claim by "The Acetylene Illuminating Company, Limited," or anyone else.

READ HOLLIDAY AND SONS, LIMITED, Acetylene Gas Engineers and Carbide of Calcium Manufacturers, HUDDERSFIELD.

NOTICE.

THE Acetylene Illuminating Company, Limited, having published and issued an advertisement or circular claiming that they hold the British Patents for the Manufacture of Calcium Carbide by means of the Electric Furnace, we guarantee to indemnify anyone who buys Carbide from us against any claim by "The Acetylene Illuminating Company, Limited," or anyone else.

TINKER AND HOLLIDAY, LIMITED, Carbide of Calcium Manufacturers, HAZELHEAD, SHEFFIELD.

TUBES AND FITTINGS
ALL KINDS
WRITE FOR PRICES
STAFFORDSHIRE TUBE Co., BIRMINGHAM.

Foolscap 4to, pp. 535, with 239 Illustrations and Steel Plate Engraving (as Frontispiece) of WILLIAM MURDOCH, *Inventor of Gas Lighting. Morocco Gilt, 21s.; Roan Gilt, 18s.*

THE SIXTH (AND CENTENARY) EDITION OF THE

HANDBOOK
FOR
GAS ENGINEERS AND MANAGERS.

BY
THOMAS NEWBIGGING,
M.Inst.C.E.

LONDON:
WALTER KING, 11, BOLT COURT, FLEET STREET, E.C.

ENRICH YOUR GAS
WITH
CHEAP BENZOL.

AT to-day's Price of Benzol, Illuminating POWER costs less than ONE-THIRD OF A PENNY PER CANDLE.

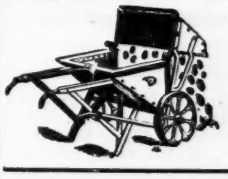
Apply to SADLER & CO., MIDDLESBROUGH.

DISPENSE WITH CANNEL COAL
and
INCREASE YOUR ILLUMINATING POWER
by using the
WHESSOE-MUNICH BENZOL CARBURETTER
The Cheapest and Best in the Market.

The Managers of Tynemouth, Middlesbrough, and Darlington Gas-Works are much pleased with it, and would not be without it.

Apply to the Sole Makers
THE WHESSOE FOUNDRY COMPANY, LIMITED, DARLINGTON.

PRICE'S COKE & COAL BARROW



effects a great saving of time, labour, and expense.

For Particulars, Price, &c., apply to Mr. EDWARD PRICE, 119, Queen's Road, FINSBURY PARK, N.

Prices are Reduced.

HEBBURN MAIN GAS COALS.

Yield of Gas per Ton . .	10,500 Cubic Feet.
Illuminating Power . . .	16·4 Candles.
Coke	68 per Cent.

For Prices, f.o.b. Ship or Delivered by Rail, apply to

The Wallsend & Hebburn Coal Company, Ltd.
B Lombard Street,
NEWCASTLE-ON-TYNE.
W. RICHARDSON, Fitter.

COKE-BREAKERS,
PRICES REDUCED.
(THOMAS & SOMERVILLE'S PATENT)
With Elevators and Conveyors worked by Steam or Gas Engine.

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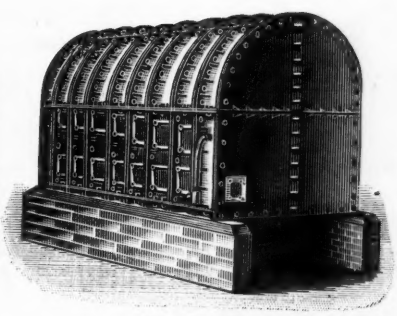

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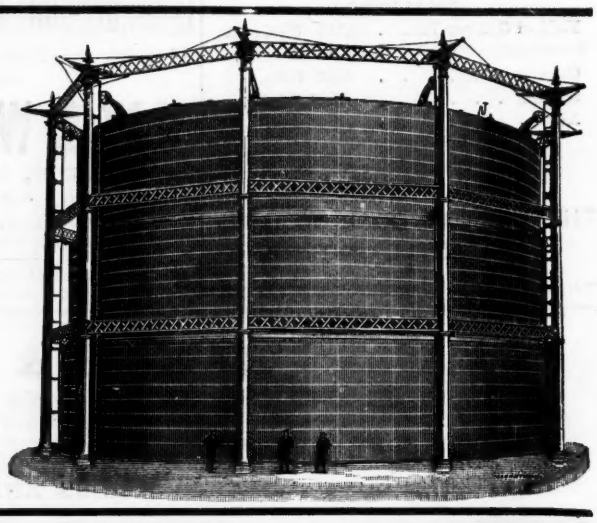

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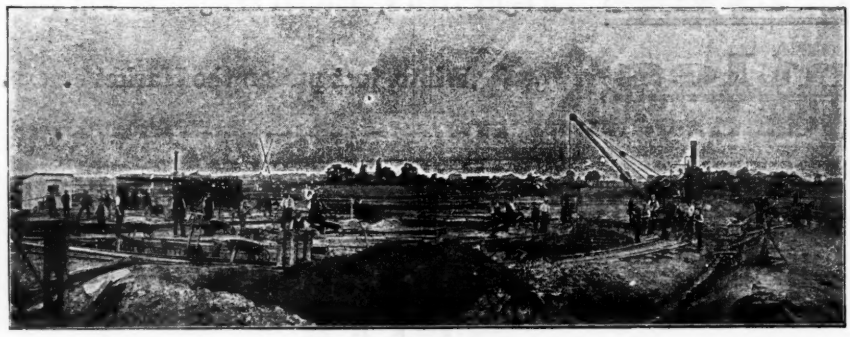

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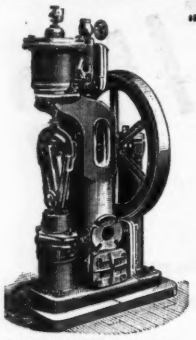

Fig. 705. "SINGLE RAM" STEAM-PUMP.

Fig. 593. "CORNISH" STEAM-PUMP FOR BOILER FEEDING, &c.

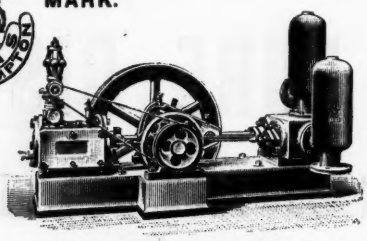

Fig. 665. "RELIABLE" STEAM-PUMP FOR TAR AND THICK FLUIDS.

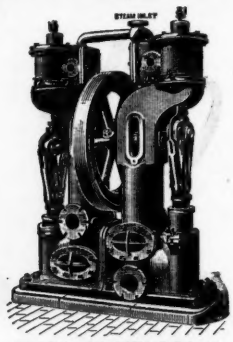

Fig. 712 "DOUBLE-RAM" STEAM-PUMP.

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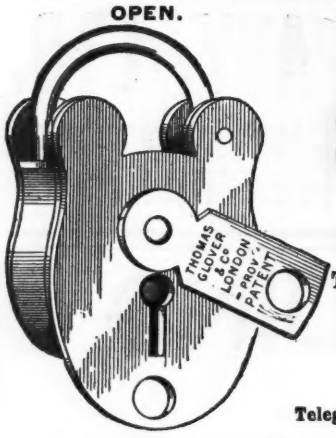

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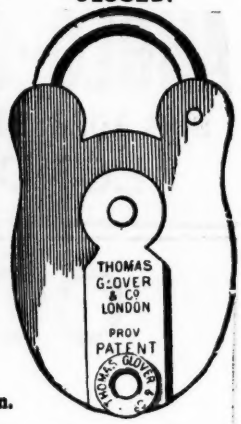

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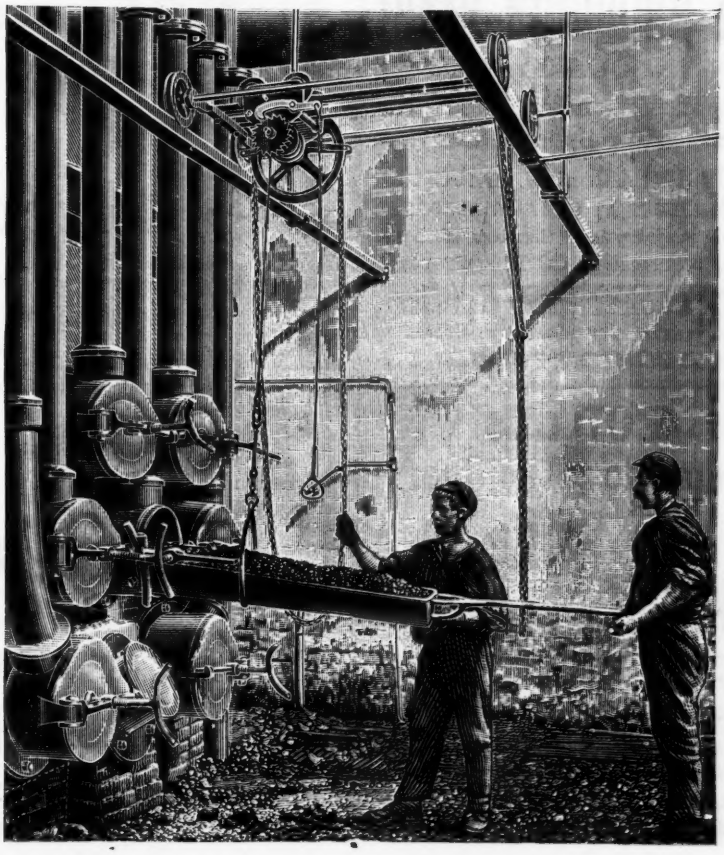

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[See Illustrated Advertisement, Feb. 7, p. 288.]

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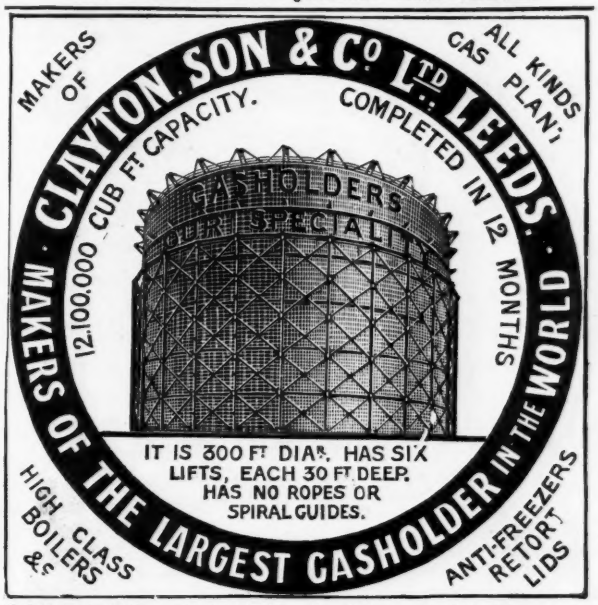
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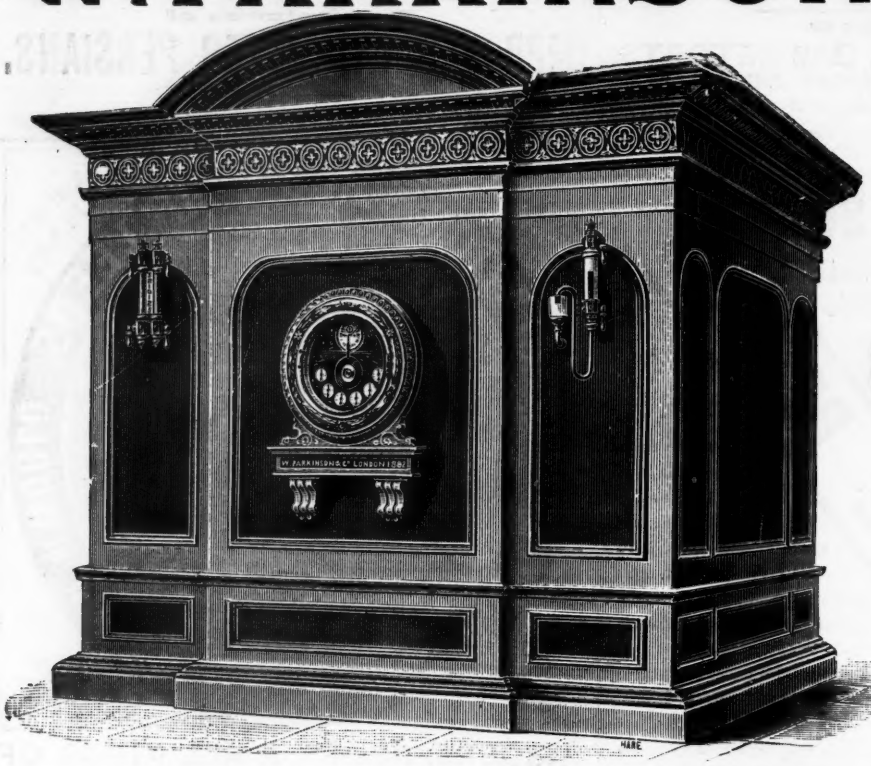

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[See also Advt. p. 426.

LONDON: Printed by WALTER KING (at the Office of King, Sell, and Railton, Ltd., 12, Gough Square); and published by him at 11, Bolt Court, Fleet Street, in the City of London.—Tuesday, Feb. 21, 1899.